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OPERATION OF THE CHEMICAL AGENT MUNITIONS DISPOSAL SYSTEM (CAMD--ETC(U)
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The CAMDS is a prototype facility for the large scale destruction of lethal chemical agents and munitions. This document contains a description of the operational aspects of the CAMDS as well as CAMDS facility/equipment descriptions.

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DEPARTMENT OF THE ARMY
OFFICE OF THE DA PROJECT MANAGER
FOR
CHEMICAL DEMILITARIZATION AND INSTALLATION RESTORATION
ABERDEEN PROVING GROUND, MARYLAND 21010

OPERATION OF THE

CHEMICAL AGENT MUNITIONS DISPOSAL SYSTEM (CAMDS)

AT

TOOELE ARMY DEPOT, UTAH

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Tooele, Utah	and Installation Restoration

CONTENTS

CONTENTS (CONT)

CONTENTS (CONT)

INCLOSURES

CONTENTS (CONT)

PAGE

LIST OF FIGURES

CONTENTS (CONT)

PAGE

LIST OF FIGURES (CONT)

PAGE

LIST OF FIGURES (CONT)

CONTENTS (CONT)

PAGE

LIST OF TABLES

INTRODUCTION

BACKGROUND

In the Fall of 1968, the Department of the Army directed the disposal of certain chemical munitions which were obsolete and excess to the national deterrent stockpile. The proposed disposal plan (Operation CHASE) provided for these munitions to be transported across country, loaded on hulks and taken under US Coast Guard escort to a previously designated explosives dumping site beyond the Atlantic continental shelf and sunk in the ocean. Included among these munitions were M55 rockets, containing the nerve agent GB, which had been encapsulated in concrete "coffins".

In a separate but related action in December 1968, the US Army Ammunition Procurement and Supply Agency (APSA) requested the US Army Munitions Command to evaluate a proposal for a mobile demilitarization system to move between various storage depots containing GB-filled rockets for onsite disposal of unserviceable items. US Army Materiel Command supported the APSA request but instructed the subordinate Munitions Command to expand the study to include an evaluation of fixed or portable systems for ecologically safe, onsite disposal of unserviceable lethal chemical material not limited to the M55 rocket. In response to these directions, US Army Edgewood Arsenal prepared a four-phased program to pilot and build a prototype demilitarization system as a means of developing the necessary technology while providing a limited demilitarization capability. US Army Materiel Command approved the program in June 1969 and provided initial funding which eventually led to the Chemical Agent/Munitions Disposal System (CAMDS).

In May 1969, the National Academy of Sciences was requested by the Director of Defense Research and Engineering, Department of Defense, for an assessment of the Operation CHASE disposal plan. An Ad Hoc Advisory Committee of the Academy, composed of 12 experts drawn from leading industrial, educational and research institutions, submitted a report to Department of Defense in June 1969 which concluded with the following statement:

"While the following comments are outside the terms of reference of the Committee, we wish to suggest to the Department of Defense that it adopt basically the same approach to chemical warfare agents and munitions that the Atomic Energy Commission has adopted toward radioactive waste products from nuclear reactors. It should be assumed that all such agents and munitions will require eventual disposal and that dumping at sea should be avoided. Therefore, a systematic study of optimal methods of disposal on appropriate military installations, involving no hazards to the general population and no pollution of the environment, should be undertaken. Appropriately, large disposal facilities should be regarded

as a required counterpart to existing stocks and planned manufacturing operations. As the first step in this direction, we suggest the construction of facilities for gradual demilitarization and detoxification of remaining M55 rockets."

The obvious intent of the National Academy of Sciences study was to avoid sea dumping in the future by providing readily available, ecologically safe means of destroying lethal chemical munitions on land. This report added impetus to the development of the Army's prototype transportable disposal system and in November 1969, work was initiated on a pilot transportable facility for M55 GB-filled rockets. High level interest in this program was expressed by a letter to the Commanding General of US Army Materiel Command from the Army Chief of Staff in February 1970 in which the expeditious development of the transportable disposal system was requested.

In May 1970, the scope of the initial pilot transportable facility was expanded to include mustard (H, HD, HT) and GB-filled 105mm cartridges and GB-filled 155mm and 8 inch projectiles. Concurrent with the development of the pilot system, Edgewood Arsenal initiated the third phase of the project which provided for the development of a technical data package for a prototype transportable facility to include demilitarization capabilities for 4.2 inch mortars containing mustard agents, 8 inch projectiles and M23 land mines containing the nerve agent VX, and ton containers of mustard (H, HD, HT), GB and VX. Edgewood Arsenal was assisted in this project by the Ammunition Equipment Office located at Tooele Army Depot. Because of the presence of a large variety of chemical munitions and the availability of specialized engineering personnel associated with the Ammunition Equipment Office, the South Area of Tooele Army Depot was selected as the initial test and operation site for the Transportable Disposal System.

In February 1971, the US Army Munitions Command directed that the separate efforts under the pilot and prototype projects be consolidated into a single project, the Transportable Demilitarization System. In addition to consolidation, the scope of the project was further expanded to include GB bombs and VX spray tanks. The inclusion of these items into the project was accomplished concurrently with a system name change to the Transportable Disposal System.

The Transportable Disposal System was intended to be operational at Tooele Army Depot by October 1973. However, in late summer 1972, the program experienced severe technical difficulties in the fabrication and testing of key subsystems which indicated a need for major technical changes and a slippage in the overall schedule. In October 1972, Edgewood Arsenal revised the program and established a readiness date of October 1976 for initiation of toxic operations. The transportability concept of the Transportable Disposal System was also relaxed in October

1972 to more accurately describe the system and the name of the system was changed to "Chemical Agent/Munitions Disposal System". To every extent practical, however, the CAMDS components were to be designed and fabricated in such a manner that they could be relocated to other demilitarization sites if necessary. It was recognized that a certain amount of new construction would be required at any other facility to support CAMDS operations.

Portions of the CAMDS facility can be relocated to accomplish limited demilitarization operations at the following locations:

Umatilla Army Depot, Hermiston, Oregon
Pueblo Army Depot, Pueblo, Colorado
Lexington-Blue Grass Depot, Richmond, Kentucky
Anniston Army Depot, Anniston, Alabama
Pine Bluff Arsenal, Pine Bluff, Arkansas
Johnston Island

OBJECTIVE

The Tooele Army Depot CAMDS facility is intended to satisfy the following specific requirements:

a. To develop and demonstrate advanced procedures and equipment for the large-scale demilitarization of lethal chemical agents and munitions.

b. To provide a facility for the disposal of 18,800 code H M55 GB-filled rockets currently located at Tooele Army Depot. In addition, CAMDS is currently being proposed as the system for disposal of approximately 100,000 additional chemical munitions of various types in condition code H at Tooele Army Depot. This plan includes the disposal of these munitions.

c. To provide a readily available facility for disposal of limited quantities of selected unserviceable lethal chemical munitions currently located at other storage depots.

It can be seen that the CAMDS facility is an experimental prototype installation as well as a limited production facility. Extensive tests have been and will continue to be conducted to assure that no elements of the system will present safety or health hazards for plant personnel or for the surrounding population. Current and planned test efforts will establish that the systems incorporated into the CAMDS will not emit pollutants in violation of any state, local, or federal standards; will not cause a significant degradation of the environment; and will not affect the surrounding ecology.

The purpose of this document is to obtain the necessary approvals required by Public Laws 91-121 and 91-441, prior to initiation of toxic operations of the CAMDS at Tooele Army Depot, Tooele, Utah. A draft Environmental Impact Statement for the Transportable Disposal System was issued in July 1971 to various Federal Government and Utah State Agencies under the title, "Transportable Disposal System Environmental Impact Statement," (Edgewood Arsenal Special Publications EASP 200-11). Due to the change in the scope of the program, a final environmental impact statement and demilitarization plan for the Transportable Disposal System were never submitted for approval. The current document has been rewritten to reflect the changes in the Transportable Disposal System which resulted in the CAMDS and voids the original documentation prepared on the Transportable Disposal System.

TOOELE ARMY DEPOT HISTORY

Tooele Ordnance Depot was established at Tooele, Utah, as a World War II Ordnance Corps Installation in accordance with War Department Letter, AG 681 (3-24-42), MR-M-SP, 7 April 1942.

The Depot underwent numerous changes in organization during the period 1943-1954 and was reconfirmed as a permanent Department of Army installation effective 1 July 1954, in accordance with DA General Order 60.

On 1 May 1955, the Deseret Chemical Depot, a Class II Chemical Corps installation, was redesignated the Deseret Depot Activity under the jurisdiction of the Chief of Ordnance. The new installation was designated as an activity of the Tooele Ordnance Depot in accordance with DA General Order 29, 29 April 1955.

DA General Order 26, 25 July 1962, transferred Tooele Ordnance Depot from the jurisdiction of the Chief of Ordnance to the jurisdiction of the Commanding General, US Army Materiel Command, effective 1 August 1962. A letter dated 24 August 1962 further assigned Tooele Ordnance Depot to the Commanding General, US Army Supply and Maintenance Command.

On 21 August 1962, DA General Order 51 renamed Tooele Ordnance Depot as Tooele Army Depot. Shortly thereafter, on 16 November 1962, DA General Order 65 discontinued the designation of the Deseret Depot Activity thus causing the identification of the area to be known as the South Area, Tooele Army Depot.

The US Army Supply and Maintenance Command was discontinued and its mission and functions were assumed by Headquarters, US Army Materiel Command, effective 1 July 1966 in accordance with AMC General Order 40, 16 June 1966.

On 30 August 1976, DARCOM Permanent Order 17-2 established the US Army Depot Systems Command. Tooele Army Depot is under the jurisdiction of this new command.

TOOELE ARMY DEPOT GEOGRAPHY (FIGURE i-1)

Tooele Army Depot consists of two areas approximately 15 miles apart. The Tooele Area or "Main Depot" occupies 24,728 acres located in the southern part of Tooele Valley, Utah, approximately 2 miles from the city of Tooele (population 14,000) and 29 miles southwest of Salt Lake City. The small community of Stockton, with a population of approximately 350, is located approximately 3 miles south of Tooele Army Depot. Grantsville, a community of approximately 2,300, is north of the west boundary of the depot.

The South Area occupies 19,364 acres in Rush Valley, Tooele County, approximately 16 miles south of Tooele City. Immediately to the southwest and west lie the small farming villages of Vernon, Clover, and St. John. The nearest community of significant size, other than Tooele, is Lehi, located 43 miles east of the South Area Main Gate. Lehi has a population of approximately 4,400.

The Tooele and Rush Valleys are bounded on the east by the Oquirrh Mountains and on the west by the Stansbury and Onaqui Mountains. The average elevation of the Tooele and Rush Valleys are 4,920 feet and 5,300 feet respectively. The two valleys are separated by a large natural dike formation approximately 2 miles south of the Main Depot area. The north end of Tooele Valley is terminated approximately 15 miles north of the depot by the Great Salt Lake.

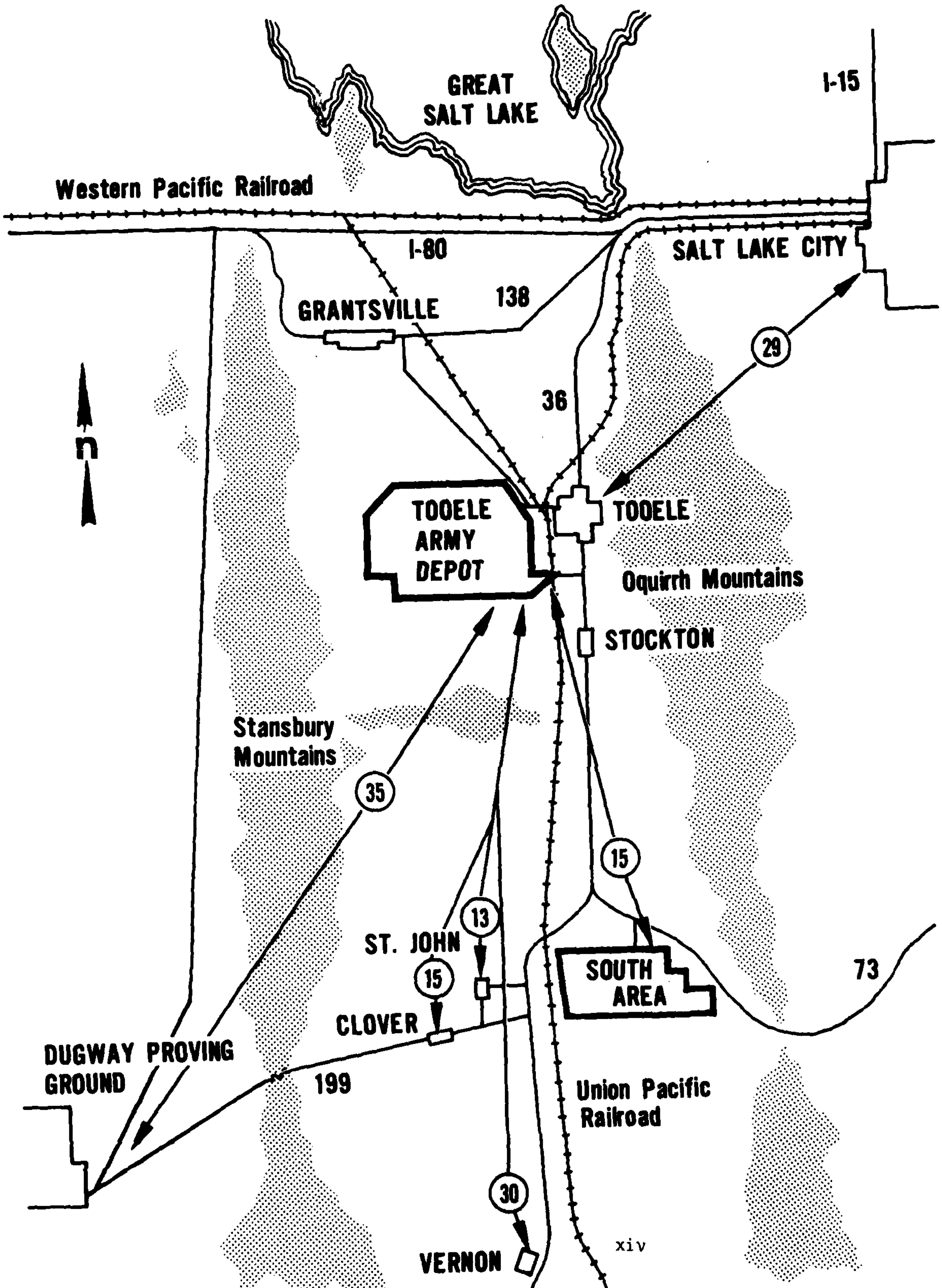


Figure i-1 Tooele Army Depot Geography

ORGANIZATIONAL RELATIONSHIPS (FIGURE 1-2)

The Department of the Army is responsible for the storage and maintenance of toxic chemical agent and agent-filled munitions for all of the military services. The US Army Armament Command is the responsible agency for the Pacific Theatre; the US Army Materiel Development and Readiness Command is the responsible agency within the continental United States. The DA Project Manager for Chemical Demilitarization and Installation Restoration is responsible for the planning, direction, and control of all development and operational aspects related to demilitarization of chemical materiel.

The Chemical Agent Munitions Disposal System (CAMDS) is being developed jointly by Edgewood Arsenal and Tooele Army Depot under the direction of the Project Manager for Chemical Demilitarization and Installation Restoration. The development and acquisition tasks have been accomplished in-house and under contract by the Ammunition Equipment Office, Tooele Army Depot, and by the Demil/Disposal Office, Edgewood Arsenal. Final plant run-in and ultimate plant operation will be performed by the CAMDS Directorate, Tooele Army Depot. During CAMDS operations, the Ammunition Equipment Office and the Demil/Disposal Office will provide technical services to the CAMDS Directorate as required. The Project Manager will exercise general program management through the Commander, Tooele Army Depot, to assure successful execution of the CAMDS operation. The Project Manager's Office will also serve as the principal point of contact for agencies outside the US Army Materiel Development and Readiness Command on all matters relative to the CAMDS operation.

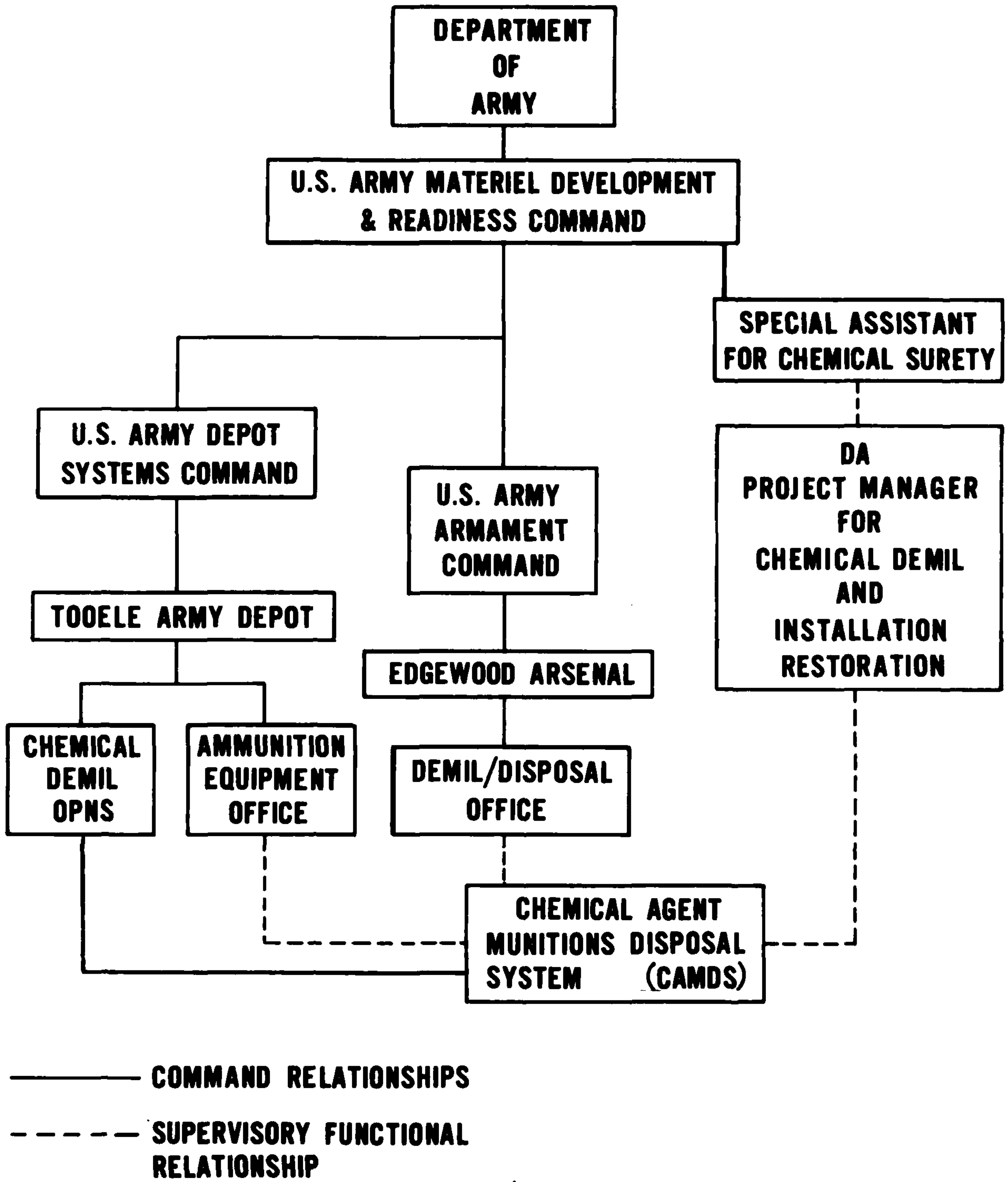


Figure i-2 Organizational Relationships

SECTION 1

OPERATIONAL PLAN

1-1 SUMMARY

The operation of the Chemical Agent/Munitions Disposal System (CAMDS) at Tooele Army Depot (TEAD) has two primary objectives:

a. Demonstration of equipment and processes for disposal of lethal chemical munitions under large scale demilitarization conditions, and

b. Disposal of code H* unserviceable lethal chemical materiel currently stored at TEAD.

The CAMDS operation described in this document will achieve both objectives through a series of relatively short operational periods in which the unserviceable materiel will be used to prove-out the facility. There are insufficient unserviceable munitions to fully test the complete capability of the plant; therefore, this plan will require the use of a limited number of munitions in the serviceable stockpile. Authority to utilize serviceable materiel for this purpose will be requested through Department of the Army on a case-by-case basis and the complete test operation will be contingent upon release of the munitions.

For the purposes of this report, the CAMDS demilitarization plan will begin with the initial processing of GB-filled M55 rockets. Operations with lethal chemical munitions will be preceded by extensive testing of the facility using simulant-filled munitions. The operation with simulants is considered the final phase of the plant development and acquisition program in which the system will be operated as an integral unit and operating procedures will be developed.

The processes and equipment to be employed for the CAMDS operation are described in greater detail in subsequent sections of this plan. Basically, the plan involves disposal of mustard agent by incineration processes, disposal of GB by reaction with sodium hydroxide solution, and disposal of VX by a chlorinolysis process. Explosives and energetic materials incorporated in the munitions will be destroyed by incineration. Inert components and metal parts will be mechanically demilitarized and decontaminated by heat treatment. All chemical products of the demilitarization processes will be placed in drums and stored onsite at Tooele Army Depot pending development of suitable final disposal means. Metal parts and other inert materials certified agent-free will be disposed of by sale through the Tooele Army Depot Property Disposal Office or by onsite land fill.

*Storage condition code H applies to munitions which have been declared unserviceable or obsolete and identified for disposal.

Toxic chemical operations in the CAMDS facility will consist of the following phases. The specific sequence and length of each operational phase will be dependent on realized processing rates and on authorization to use serviceable materiel for test. In each case, demilitarization operations will be conducted on a single, eight-hour shift, five days a week, with a second maintenance shift as required. As operational experience is gained, and if the CAMDS workload dictates, additional shifts may be added at a later date.

a. M55 GB Rocket System Integration. After authority is received to begin demilitarization operations, and extending for a period of approximately three months, the CAMDS facility will be operated with code H unserviceable M55 GB rockets to verify the rocket demilitarization rate, operating procedures, and the system reliability. For planning purposes, it is estimated that 2,500 M55 rockets will be destroyed during this period to "run-in" the facility.

b. Demilitarization of Code H GB Rockets. Immediately following rocket system integration, the CAMDS facility will be operated under full-scale demilitarization conditions for the disposal of approximately 16,300 code H unserviceable GB-filled M55 rockets. This period is expected to last approximately thirteen months; however, the operational period is directly dependent on the attainable demilitarization rates, which will not be established with certainty until the end of the system integration period (phase a). In practice, there may be little distinction between system integration and full-scale demilitarization. Efforts to improve and optimize plant performance will continue throughout this period. In addition, the code H M55 rockets to be destroyed could increase before the planned operation is complete.

c. Non-Burstered Projectile System Integration. Following the disposal of code H GB-filled rockets, the CAMDS facility will be tested with non-burstered 155mm GB projectiles. This operation will include processing of approximately 250 simulant-filled, non-explosive projectiles and 2,500 code H unserviceable GB-filled, non-explosive projectiles (M121 and M122). The objective of the operation will be to verify projectile processing rates, operating procedures, and system reliability. This phase is expected to last approximately ten weeks. During this operation, M55 rocket demilitarization machinery will be decontaminated and removed from the system and will be replaced by equipment required for processing burstered projectiles.

d. Demilitarization of Code H Non-Burstered GB Projectiles. At the conclusion of phase c, the CAMDS facility will be operated on a full-scale demil basis for the destruction of approximately 44,000 code H unserviceable 155mm GB projectiles (M121) during a period of approximately eighteen months. As in the case of rocket disposal, the period of operation is dependent upon production rates realized during the system integration program and upon the number of code H projectiles identified for disposal at Tooele Army Depot at that time.

e. Bulk Item Facility System Integration with MC-1 GB-Filled Bombs. The bomb handling capability of the CAMDS facility will be tested immediately following the disposal of code H 155mm GB projectiles. During this period of approximately three months, 20 simulant-filled MC-1 bombs and 100 GB-filled MC-1 bombs will be processed through the bulk item facility to verify handling rates and equipment reliability. Two of these items are code H unserviceable. The remainder must be obtained from serviceable stocks. The length of this period is dependent on the success of the test effort and the availability of serviceable materiel for test.

f. Burstered Projectile System Integration. The capability of the CAMDS facility to demilitarize burstered projectiles will be tested using approximately 250 simulant-filled 105mm M360 projectiles followed by approximately 750 GB-filled code H M360 projectiles. At the conclusion of this operation, the projectile demilitarization equipment exposed to agent GB will be chemically decontaminated to prepare for operations with burstered mustard projectiles. The demilitarization system will then be tested with approximately 2,500 code H 155mm mustard-filled projectiles (M104 and M110). This operation will be performed over a period of approximately five months. As in the other system integration phases, the objective of this operation will be to verify equipment processing rates, operating procedures, and system reliability. Also in the period of mustard projectile operation, the bulk item facility and the agent destruction systems will be decontaminated and prepared for VX operations.

g. Demilitarization of Code H Burstered Mustard Projectiles. At the conclusion of system integration with the 155mm mustard projectiles in the previous phase, the CAMDS facility will be used to dispose of approximately 52,100 code H 155mm burstered H and HD munitions (M104 and M110). This operation is expected to last approximately eighteen months depending upon the actual demilitarization rates which will be determined during system integration and depending on the size of the unserviceable stockpile existing at Tooele Army Depot at that time. At the conclusion of this operation, projectile handling equipment will be decontaminated and will be replaced in the system by mortar processing equipment.

h. Mustard Ton Container System Integration. During the changeover of projectile handling equipment to 4.2 inch mortar equipment, the CAMDS facility will be operated on mustard-filled ton containers to verify production rates, plant reliability and operating procedures unique to the mustard ton container demilitarization process. This phase of the program will only require the metal parts furnace, the agent destruction system salt drying plant and support equipment and will not be interfered with by the changeover of munition handling equipment in other parts of the CAMDS facility. This operation will require approximately five simulant-filled ton containers and approximately 50 mustard-filled ton containers which are currently in the serviceable stockpile. The

operation will last approximately three months depending on the success of the tests and the availability of mustard ton containers from the serviceable stockpile.

i. 4.2 Inch Mortar System Integration. The capability of the CAMDS facility to dispose of 4.2 inch mustard-filled mortar projectiles will be verified during this period of the CAMDS operation. Approximately 250 simulant-filled mortars will be processed through the system followed by approximately 2,500 mustard-filled mortars. Thirty of these items are currently in condition code H containing HT mustard. The remainder will be serviceable HD items unless additional code H items are available at Tooele Army Depot at that time. As with previous integration tests, the objective of this operation will be to verify munition processing rates, operating procedures, and system reliability. The operation will last approximately fifteen weeks depending on success of the tests and availability of munitions.

j. Bulk Item Facility System Integration with VX Ton Containers. Immediately following the system integration with mortars, the processing equipment involved will be decontaminated and the plant will be readied for operations on VX-filled M23 land mines and 155mm VX projectiles. These two systems may be operated concurrently without interference of equipment. Decontamination and removal of mortar equipment and replacement with the mine demilitarization equipment will require approximately two months. While VX munition handling equipment is being readied in part of the CAMDS facility, ton containers of VX will be drained in the bulk item facility for the dual purpose of testing the draining system and supplying VX to test the agent destruction system. This operation will continue only until the M23 mine and 155mm VX projectile systems are ready to provide agent. No more than 30 VX ton containers will be required during this period of approximately eight weeks duration.

k. M23 VX Mine System Integration. This phase of CAMDS will involve integration of the system on M23 land mines. Approximately 500 simulant-filled mines will be processed initially for equipment shakedown followed by system integration with approximately 2,500 VX-filled land mines which are in condition code H. The operation will be performed over a period of approximately twelve weeks depending upon the success of equipment operations and the availability of serviceable munitions. As in the previous systemization operations, the purpose of this test will be to verify processing rates, operating procedures, and plant reliability.

l. Disposal of 155mm VX Projectiles. Concurrently with the M23 VX mine system integration, approximately 580 VX-filled 155mm, M121 projectiles in condition code H will be demilitarized. This operation does not require the same munition process equipment as the M23 land mine process and can be accomplished in less than one month.

m. Site Clean-Up. The operations cited above will conclude the CAMDS systemization program and will also result in disposal of most of the unserviceable rounds currently at Tooele Army Depot. Unless an additional workload for the CAMDS facility is identified, the facility will be cleaned, decontaminated and placed in standby condition over a 6 month period. The total system integration and disposal of unserviceable rounds is expected to be completed in 7 years and will be influenced by actual demilitarization rates established during operations, and availability of munitions for demilitarization. The tentative schedule for the CAMDS Operational plan is shown in Figure 1-1.

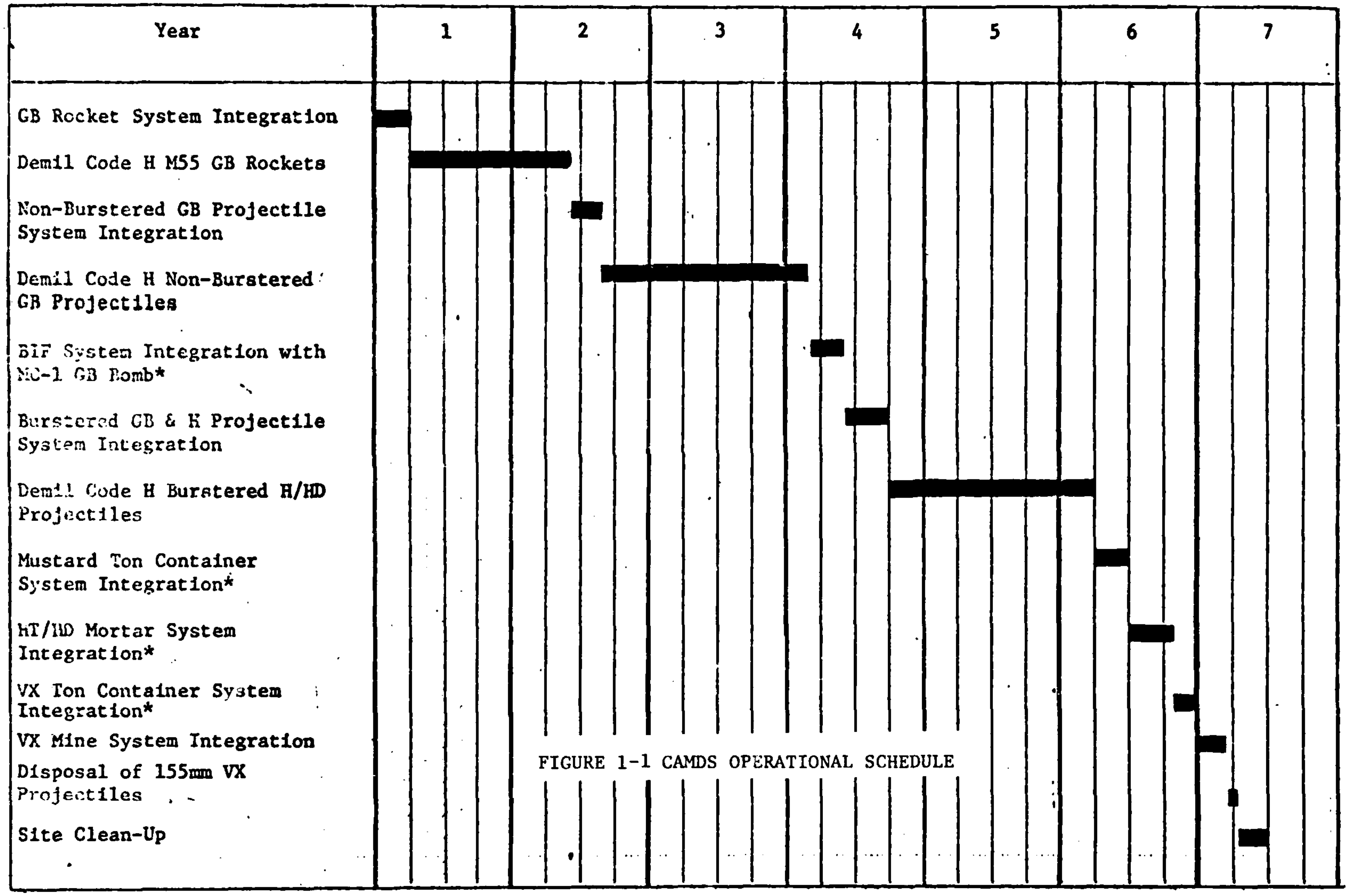


FIGURE 1-1 CAMDS OPERATIONAL SCHEDULE

*Serviceable materiel

1-2 ALTERNATIVES TO THE CAMDS PROGRAM

The attainment of a means to dispose of chemical munitions is essential to the Department of Defense. The alternative to disposal is the indefinite retention in storage. As munitions become obsolete due to deterioration, obsolescence of delivery systems, or the introduction of new weapons systems, they become excess to the national defense requirement. Their retention in storage results in continuing costs for surveillance, security and renovation as well as potential safety hazards. The munitions and chemical agents have a finite life and eventual disposal is inevitable. Permanent retention in storage is not a viable alternative to the development of the Chemical Agent/Munitions Disposal System (CAMDS).

As previously stated, this project is an outgrowth of earlier efforts by the Department of Defense to dispose of excess and obsolete stocks by dumping at sea. Until the review by the National Academy of Sciences, burial at sea was an accepted method for disposal of lethal chemical agents and munitions. However, the Academy was concerned about the effects of agents on fish and unicellular and larval organisms. Since no quantitative data was available, the effects of large quantities of agents on the oceanic ecosphere could not be predicted. The destruction of mustard agent by incineration was common practice and the chemical neutralization of GB was well known. The Academy considered these to be preferable methods of disposal and recommended against sea dump.

1-3 ALTERNATIVES TO CAMDS PROCESSES

a. Mustard Disposal Process. In July 1972, a report was published by a US Army Munitions Command (MUCOM) Ad Hoc Committee on the Demilitarization of Chemical Munitions/Agents which recommended incineration of mustard as the best method for disposal because this technology was well known and had been used successfully at Rocky Mountain Arsenal. Alternatives to mustard incineration were addressed in the plan for Project EAGLE, Phase 1, which involved disposal of H ton containers at Rocky Mountain Arsenal. No additional consideration was given to alternate mustard disposal methods in the CAMDS program.

Alternate techniques to accomplish the incineration of mustard agents were considered. Draining of mustard projectiles and ton containers and transfer of the agent to a liquid incinerator was considered along with a simplified process of volatilizing mustard directly from its containers. The transfer process was employed at Rocky Mountain Arsenal and difficulties were encountered in handling mustard sludge. Pilot tests at Rocky Mountain Arsenal on the volatilization process demonstrated its relative simplicity and economic advantage and this process was subsequently selected for application in CAMDS.

b. Nerve Agent Disposal Processes. In the early stages of the CAMDS program, laboratory and pilot plant experimentation was performed to compare various methods for disposal of GB and VX. These agents were successfully incinerated on a laboratory and small pilot plant scale and, indeed, incineration was the initial process of choice; however, the report of the MUCOM Ad Hoc Committe, in July 1972, recommended that only in those cases where chemical destruction appeared impractical should there be recourse to the pyrolysis of nerve agents.

Destruction of GB by neutralization with aqueous sodium hydroxide was the well-proven process for large-scale destruction of GB under the M34 demilitarization program at Rocky Mountain Arsenal. On this basis, caustic neutralization of GB was selected as the process for CAMDS.

Alternate chemical destruction methods for VX included reaction with calcium hypochlorite in aqueous acidic and basic solutions and direct chlorination with chlorine gas in aqueous hydrochloric acid solution. Of these three systems, reaction with chlorine gas was found to be the most efficient means for destruction of bulk quantities of VX. The acidic calcium hypochlorite reaction was highly efficient but was a critical function of solution pH. In basic solutions, the reaction produced an intermediate compound of considerable toxicity. Based on this experimentation, the chlorine gas process was ultimately selected for CAMDS application.

c. <u>Other Processes</u>. More exotic methods for disposal of nerve agents and mustard agent, involving electrochemical reaction, biodegradation and reactions with carbonaceous activated water, have theoretical possibilities. However, in general, these processes require use of dilute solutions necessitating handling of large volumes, generate by-products with additional disposal problems, and would require extensive research and development to establish process parameters and operational safety criteria. In addition, these processes appear to offer no significant operational advantages over the chosen processes.

SECTION 2

MUNITION DESCRIPTION

2-1 GENERAL

The CAMDS will provide a capability for complete demilitarization of all lethal chemical agent-filled projectiles, rockets, mines, bombs, spray tanks and bulk quantities of agent stored in ton containers with the exception of the Weteye Bomb. The munitions are of various types, some of which include fuses, explosive burster charges and rocket propellant in addition to the liquid nerve agents or blister agent. A typical association of components for artillery projectiles is shown in Figure 2-1 below.

Technical data regarding the items which may be processed in the CAMDS at TEAD are listed in Table 2-1. Drawings depicting each of the items are shown in Figures 2-2 through 2-17. A description of the agents is contained in Section 5.

A description of the explosive fillers is contained in Table 2-2. All explosive components will be demilitarized in the CAMDS with the exception of the propellant for the 105mm cartridge, the propellant, primer, and igniter for the 4.2 inch mortar, and the fuze and activator for the M23 mine. Unless these explosive components are contaminated with leaking chemical agent, they will be returned to storage for reuse or for conventional disposal. If these components are suspected of being contaminated, they will be thermally destroyed in the CAMDS facility.

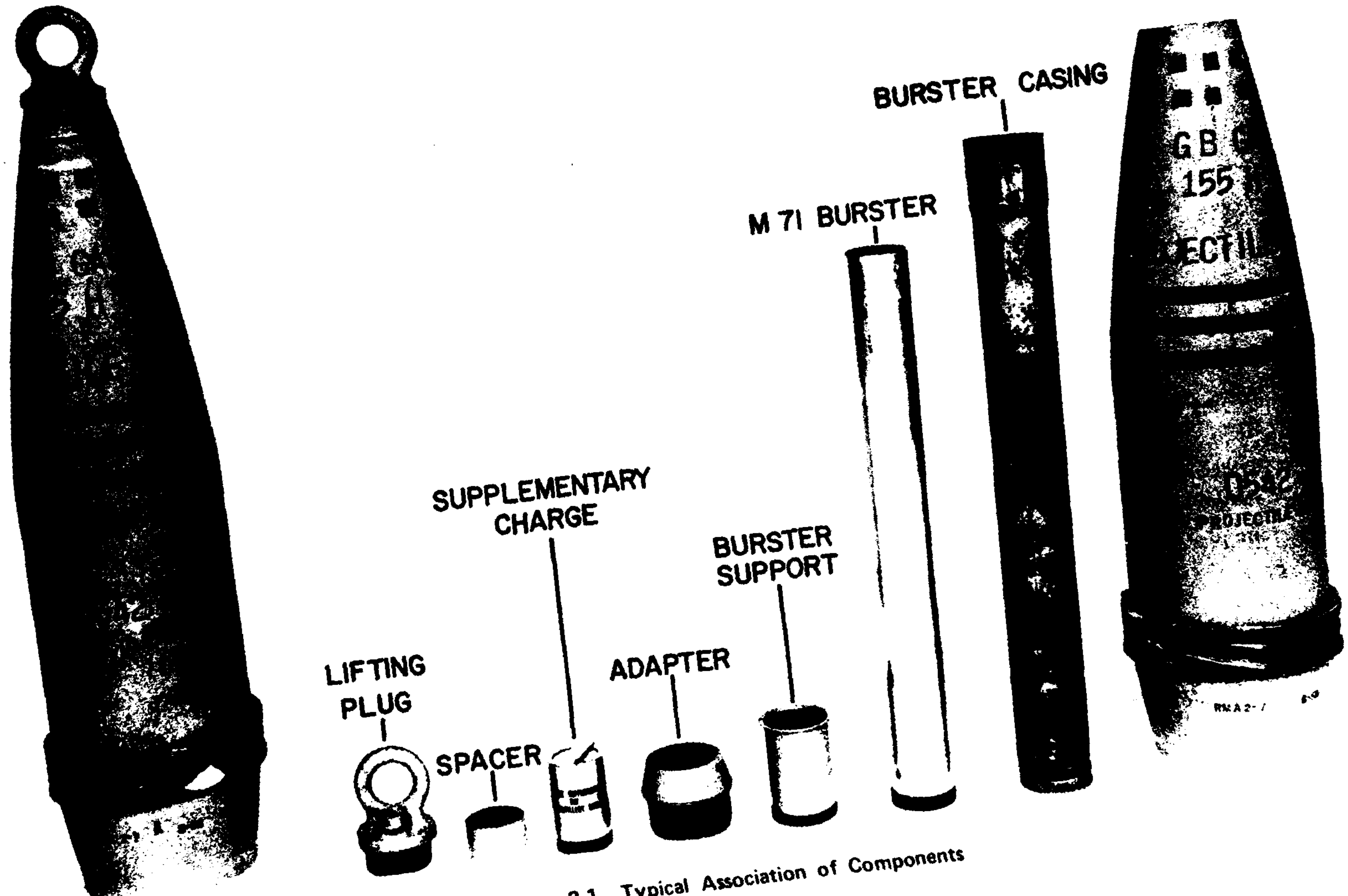
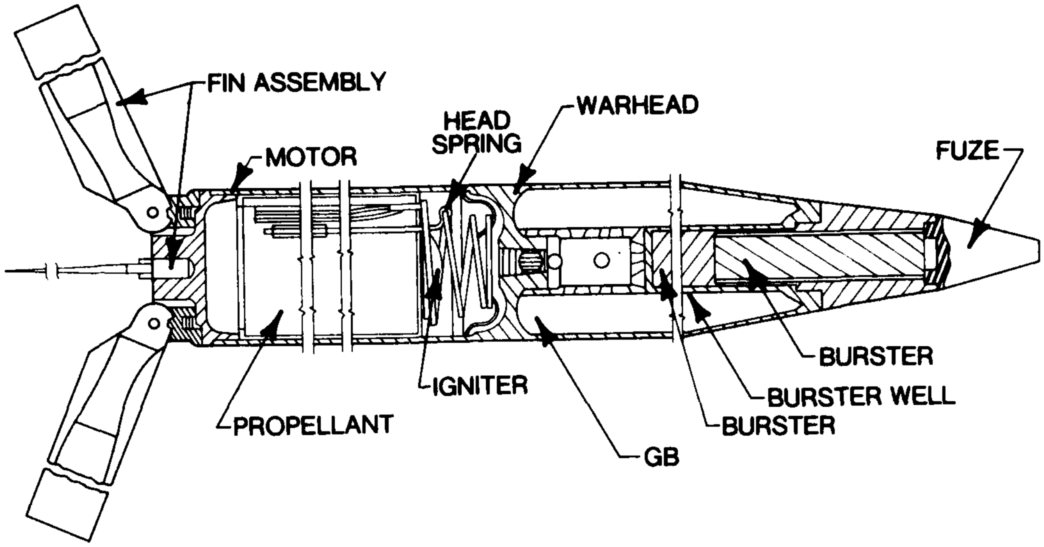


Figure 2-1 Typical Association of Components

TABLE 2-1
MUNITIONS TO BE PROCESSED BY CAMDS

Munitions	Physical Data			Agent		Explosive		Propellant		Fuze
	Lgth (in)	Diam	Total Wt (lb)	Type	Weight (lb)	Type	Weight (lb)	Type	Weight (lb)	
Rocket, 115mm, M55	78.0	115mm	57	GB	10.7	Comp B	3.2	M28	19.3	M417
Cartridge, 105mm, M360*	31.1	105mm	44	GB	1.6	Tetrytol	1.1	M1	2.75	M508
Projectile, 155mm, M121A1	26.7	155mm	100	GB	6.5	None	None	None	None	None
Projectile, 155mm, M121	26.7	155mm	100	GB	6.5	None	None	None	None	None
Projectile, 155mm, M122	26.7	155mm	100	GB	6.5	None	None	None	None	None
Projectile, 8-inch, M426	35.1	8 in	199	GB	14.5	None	None	None	None	None
Bomb, 750 lb, MC1	50.0	16 in	725	GB	220.0	None	None	None	None	None
Projectile, 155mm, M121A1	26.7	155mm	100	VX	6.0	None	None	None	None	None
Rocket, 115mm, M55	78.0	115mm	56	VX	10.0	Comp B	3.2	M28	19.3	M417
Mine, 2 gal, M23	5.0	13.5 in	23	VX	10.5	Comp B	0.8	None	None	M603
Tank, Spray, TMU-28/B	185.5	22.5 in	1935	VX	1356.0	None	None	None	None	None
Cartridge, mortar, 4.2-inch, M2/M2A1	21.0	4.2 in	25	HD	6.0	Tetryl	0.14	M6	0.4	M8
Cartridge, mortar, 4.2-inch, M2/M2A1	21.0	4.2 in	25	HT	5.8	Tetryl	0.14	M6	0.4	M51A5
Projectile, 155mm, M110	26.8	155mm	99	H	11.7	Tetrytol	0.41	None	None	None
Projectile, 155mm, M104	26.8	155mm	95	HD	11.7	Tetrytol	0.41	None	None	None
Ton Container	81.5	30.1 in	3100	HD	1700.0	None	None	None	None	None
Ton Container	81.5	30.1 in	2900	GB	1500.0	None	None	None	None	None
Ton Container	81.5	30.1 in	3000	VX	1600.0	None	None	None	None	None

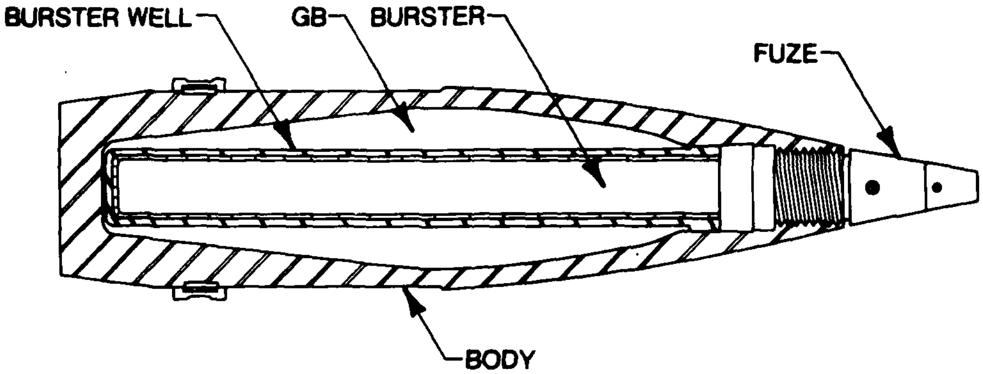
*Note: Cartridge, 105mm, M360 is configured with/without bursters, fuzes and cartridge cases.



NSN: 1340-00-716-1450-H520

LENGTH	78.0 in.
DIAMETER	115mm
TOTAL WT.	57 lb.
AGENT	GB
AGENT WT.	10.7 lb.
FUZE	M417
BURSTER	M34, M36
EXPLOSIVE	Comp B
EXPLOSIVE WT.	3.2 lb.
PROPELLANT	M28
PROPELLANT WT.	19.3
PRIMER	M62
QD/SCG	5A
PACKAGING	15 rounds/wooden pallet

FIGURE 2-2 ROCKET, 115mm, GB, M55



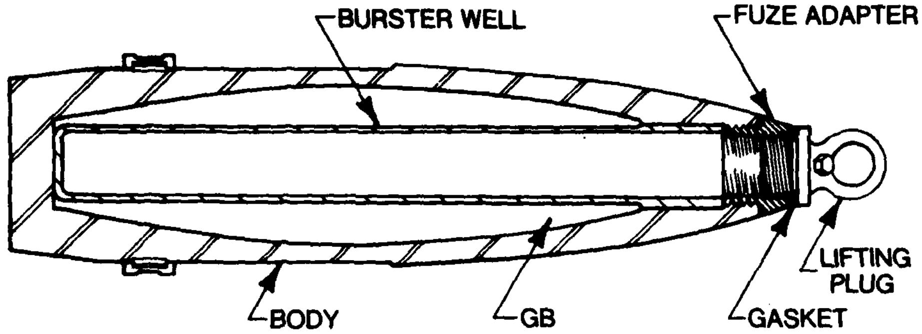
NOTE:
PROJECTILE IS STORED WITH AND WITHOUT FUZE AND BURSTER.
FUZE CAVITY OF UNFUZED UNBURSTERED PROJECTILE IS SEALED BY A CLOSING PLUG.

NSN: 1315-00-203-8985-C441

LENGTH	31.1 in.
DIAMETER	105mm
TOTAL WT.	44 lb.
AGENT	GB
AGENT WT.	1.63 lb.
FUZE	M508
BURSTER	M40, M40A1
EXPLOSIVE	Tetrytol(M-40) Comp B(M40A)
EXPLOSIVE WT.	1.12 lb.
PROPELLANT	M1
PROPELLANT WT.	2.75 lb.
PRIMER	M28B2, M28A2
QD/SCG	5A
PACKAGING	1 Round, fiber container/ 2 containers/wooden box

NOTE: IN ADDITION TO COMPLETE ROUNDS (PROJECTILE, BURSTER, FUZE, CARTRIDGE CASE AND PROPELLANT) PROJECTILES WITHOUT BURSTERS WILL ALSO BE PROCESSED.

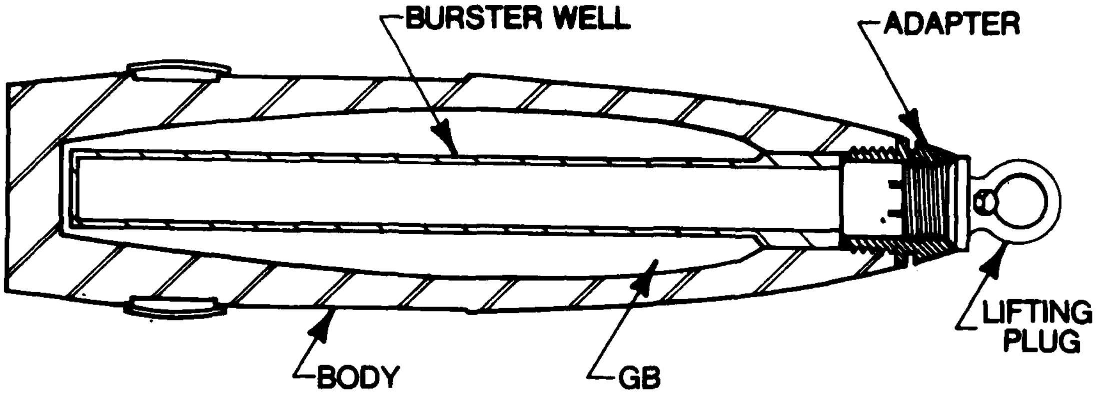
FIGURE 2-3 CARTRIDGE, 105mm, GB, M360



NSN: 1320-00-059-3536-D542

LENGTH	26.7 in.
DIAMETER	155mm
TOTAL WT.	100 lb.
AGENT	GB
AGENT WT.	6.5 lb.
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	8 rounds/wooden pallet

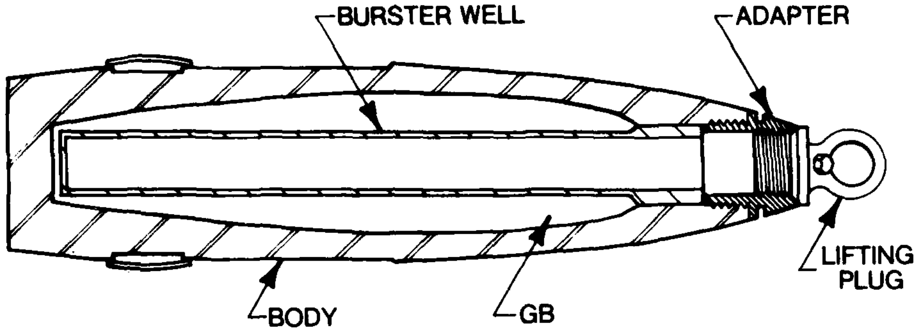
FIGURE 2-4 PROJECTILE, 155mm, GB, M121A1



NSN: 1320-00-567-7909-D542

LENGTH	26.7 in.
DIAMETER	155mm
TOTAL WT.	100 lb.
AGENT	GB
AGENT WT.	6.5 lb.
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	8 rounds/wooden pallet

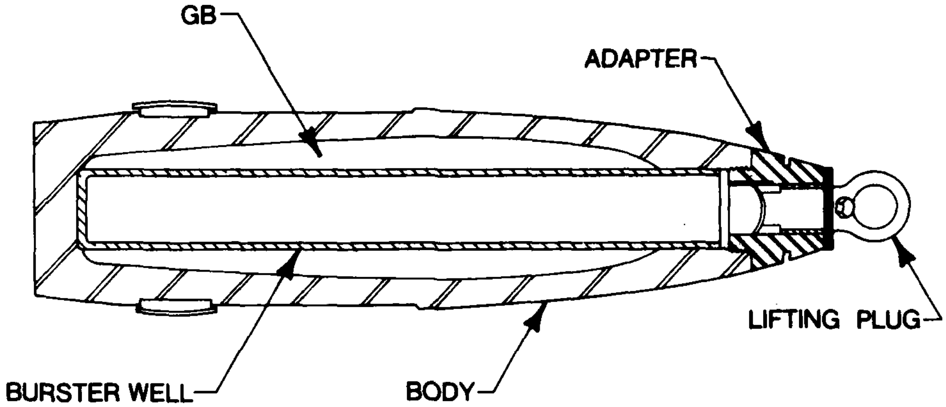
FIGURE 2-5 PROJECTILE, 155mm, GB, M121



NSN: 1320-00-529-9033-D483

LENGTH	26.7 in.
DIAMETER	155mm
TOTAL WT.	100 lb.
AGENT	GB
AGENT WT.	6.5 lb.
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	8 rounds/wooden pallet

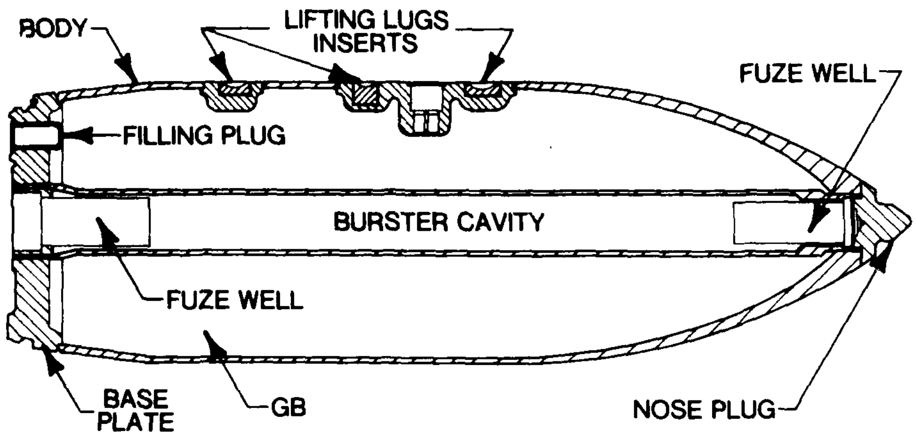
FIGURE 2-6 PROJECTILE, 155mm, GB, M122



NSN: 1320-00-592-4305-D696

LENGTH	35.1 in.
DIAMETER	8 in.
TOTAL WT.	199 lb.
AGENT	GB
AGENT WT.	14.5 lb.
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	6 rounds/wooden pallet

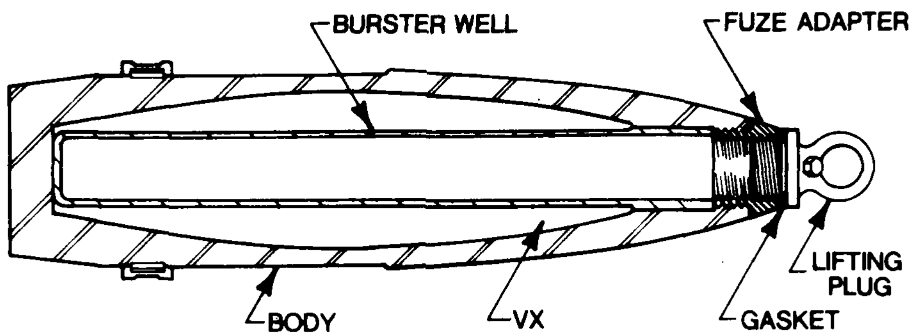
FIGURE 2-7 PROJECTILE, 8-INCH, GB, M426



NSN: 1325-00-554-1173-E388

LENGTH	50 in.
DIAMETER	16 in.
TOTAL WT.	725 lb.
AGENT	GB
AGENT WT.	220 lb.
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	2 bombs/wooden pallet

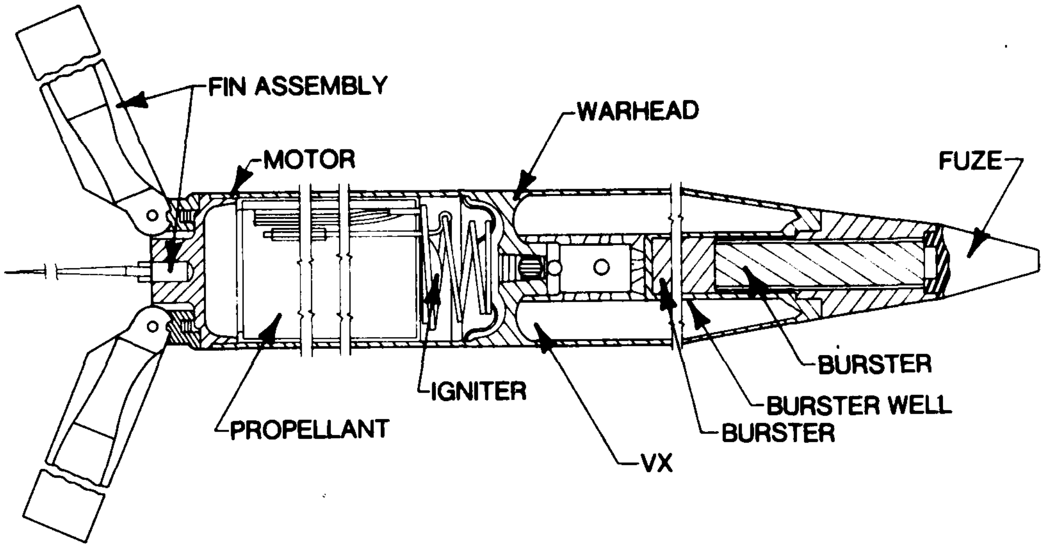
FIGURE 2-8 BOMB, 750 lb., GB, MC-1



NSN: 1320-00-059-3535-D568

LENGTH	26.7 in.
DIAMETER	155mm
TOTAL WT.	100 lb.
AGENT	VX
AGENT WT.	6.0 lb.
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	8 rounds/wooden pallet

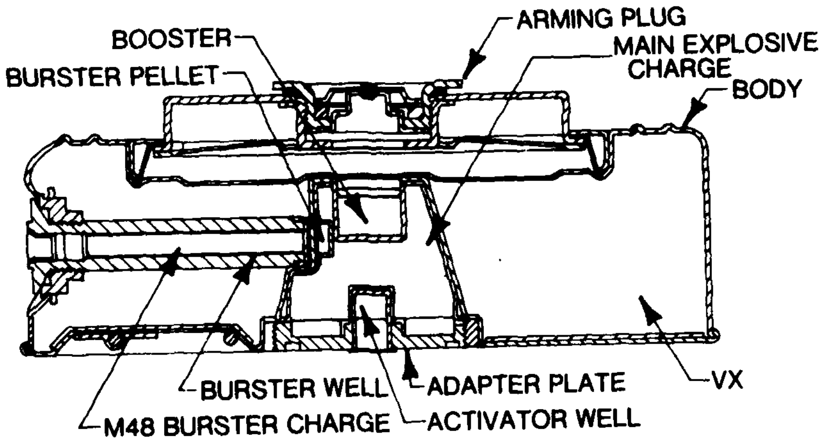
FIGURE 2-9 PROJECTILE, 155mm, VX, M121A1



NSN: 1340-00-724-3567-H521

LENGTH	78 in.
DIAMETER	115mm
TOTAL WT.	56 lb.
AGENT	VX
AGENT WT.	10.0 lb.
FUZE	M417
BURSTER	M34, M36
EXPLOSIVE	Comp B
EXPLOSIVE WT.	3.2 lb.
PROPELLANT	M67
PROPELLANT WT.	19.3 lb.
PRIMER	M62
QD/SCG	5A
PACKAGING	15 rounds/wooden pallet

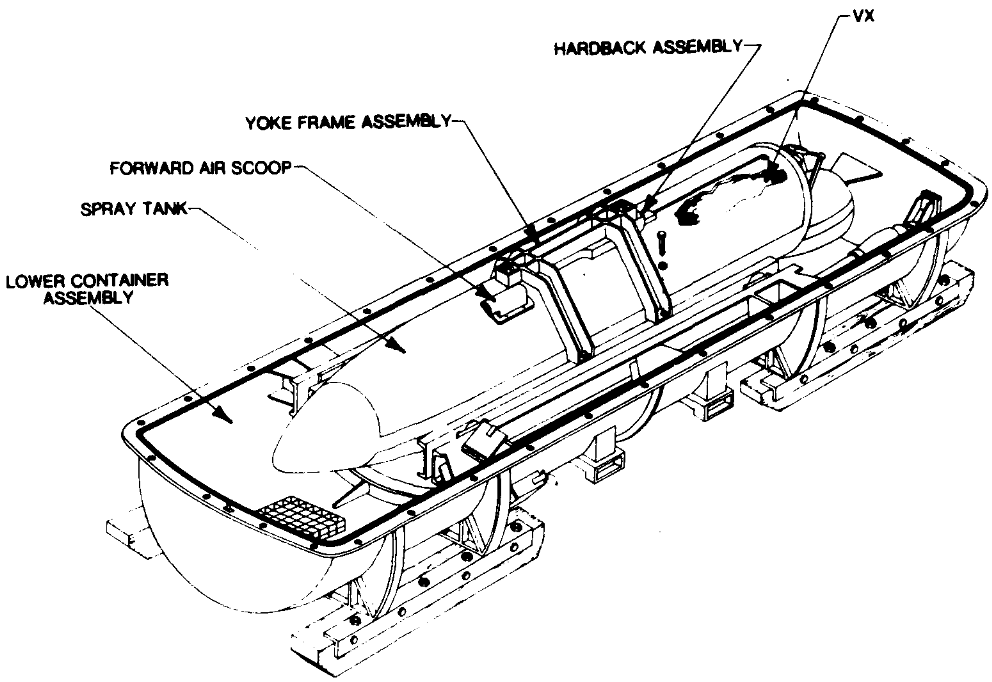
FIGURE 2-10 ROCKET, 115mm, VX, M55



NSN: 1345-00-542-1580-K257

HEIGHT	5 in.
DIAMETER	13.5 in.
TOTAL WT.	23 lb.
AGENT	VX
AGENT WT.	10.5 lb.
FUZE	M603
BURSTER	M38
EXPLOSIVE	Comp B
EXPLOSIVE WT.	.8 lb.
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	N/A
QD/SCG	5A
PACKAGING	3 mines/steel drum

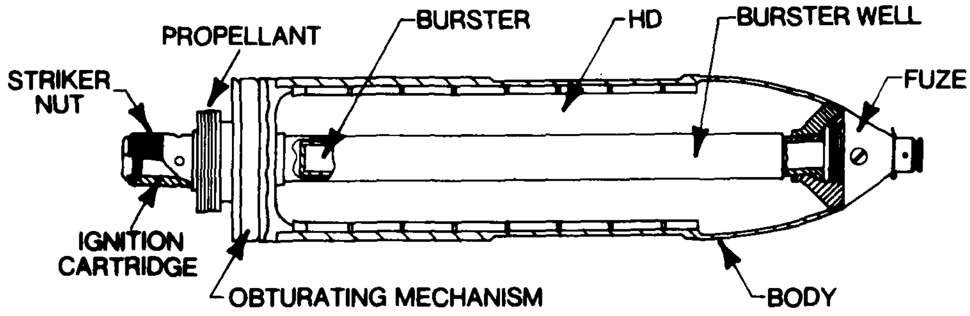
FIGURE 2-11 MINE, 2 GALLON, VX, M23



NSN: 1325-00-900-5542-D432

LENGTH	185 in.
DIAMETER	22.5 in.
TOTAL WT.	1935 lb.
AGENT	VX
AGENT WT.	1356 lb.
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	1 tank/steel container

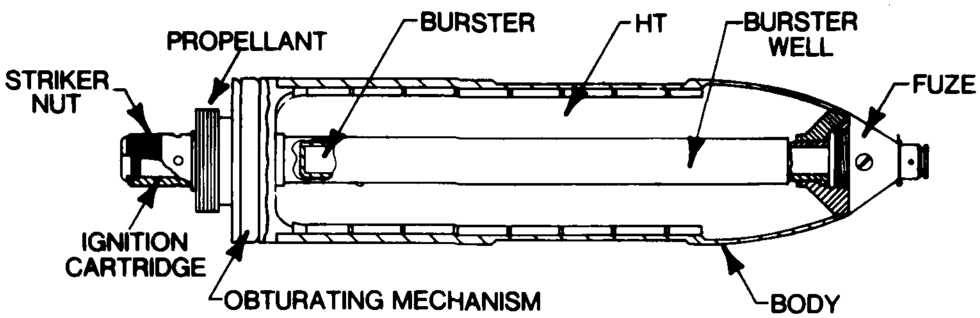
FIGURE 2-12 TANK, SPRAY, VX, TMU-28/B



NSN: 1315-00-028-5024-C703

LENGTH	21.0 in.
DIAMETER	4.2 in.
TOTAL WT.	25 lb.
AGENT	HD
AGENT WT.	6.0
FUZE	M8
BURSTER	M14
EXPLOSIVE	Tetryl
EXPLOSIVE WT.	.14 lb.
PROPELLANT	M6
PROPELLANT WT.	.4 lb.
PRIMER	M28A2
QD/SCG	5A
PACKAGING	1 round/fiber container/ 2 containers/wooden box

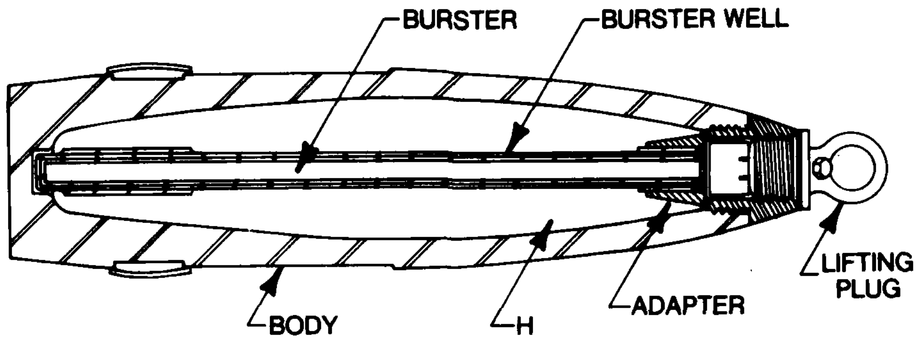
FIGURE 2-13 CARTRIDGE, MORTAR, 4.2 INCH, HD, M2/M2A1



NSN: 1315-00-028-5024-C703

LENGTH	21.0 in.
DIAMETER	4.2 in.
TOTAL WT.	25 lb.
AGENT	HT
AGENT WT.	5.8 lb.
FUZE	M51A5
BURSTER	M14
EXPLOSIVE	Tetryl
EXPLOSIVE WT.	.14 lb.
PROPELLANT	M6
PROPELLANT WT.	.4 lb.
PRIMER	M28A2
QD/SCG	5A
PACKAGING	1 round/fiber container/ 2 containers/wooden box

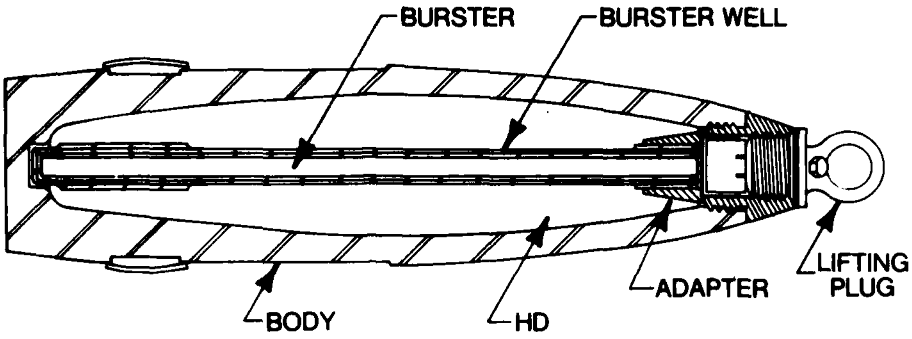
FIGURE 2-14 CARTRIDGE, MORTAR, 4.2 INCH, HT, M2/M2A1



NSN: 1320-00-301-1824-D543

LENGTH	26.8 in.
DIAMETER	155mm
TOTAL WT.	99 lb.
AGENT	H
AGENT WT.	11.7 lb.
FUZE	None
BURSTER	M6
EXPLOSIVE	Tetrytol
EXPLOSIVE WT.	.41 lb.
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	5A
PACKAGING	6 rounds/wooden pallet

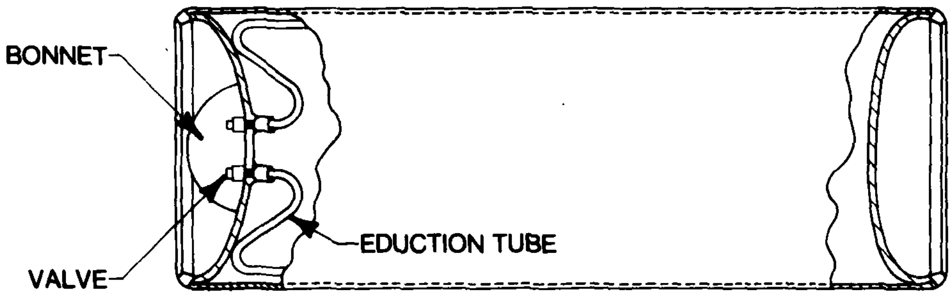
FIGURE 2-15 PROJECTILE, 155mm, H, M110



NSN: 1320-00-965-0704-D484

LENGTH	26.8 in.
DIAMETER	155mm
TOTAL WT.	95 lb.
AGENT	HD
AGENT WT.	11.7 lb.
FUZE	None
BURSTER	M6
EXPLOSIVE	Tetrytol
EXPLOSIVE WT.	.41 lb.
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	5A
PACKAGING	6 rounds/wooden pallet

FIGURE 2-16 PROJECTILE, 155mm, HD, M104



NSN: 1365-00-277-3041-K665, HD
NSN: 1365-00-293-9239-K725, GB
NSN: 1365-00-541-7209-K732, VX

LENGTH	81.5 in.		
DIAMETER	30.1 in.		
TOTAL WT.	3100 lb.;	2900 lb.;	3000 lb.
AGENT	HD,	GB,	VX
AGENT WT.	1700	1500	1600
FUZE	None		
BURSTER	None		
EXPLOSIVE	None		
EXPLOSIVE WT.	N/A		
PROPELLANT	None		
PROPELLANT WT.	N/A		
PRIMER	None		
QD/SCG	8A		
PACKAGING	None		

FIGURE 2-17 TON CONTAINER

2-2 EXPLOSIVES

The three high explosives used in bursters for chemical munitions are Composition B, Tetryl and Tetrytol. The characteristics of these explosives and their primary ingredients are listed in Table 2-2.

The M67 rocket motor employed with the M55 rocket contains M28 propellant and an M62 igniter. The propellant is a 19.3 pound double-base cast grain in cruciform configuration consisting of the following components expressed as a percent of the total grain weight:

Nitrocellulose	-	60.0
Nitroglycerin	-	23.8
Triacetin	-	9.9
Dimethylphthalate	-	2.6
Nitrodiphenylamine	-	1.7
Lead Stearate	-	2.0

The igniter consists of a polyethylene bag containing pellets of potassium perchlorate and magnesium, a small booster, and two M2 electrical squibs. Although the rocket motor is an energetic material, it is not considered an explosive. Tests by the US Army Ballistic Research Laboratory and Tooele Army Depot have verified that the motor does not add to the explosive output of an M55 rocket for purposes of quantity-distance separation criteria.

TABLE 2-2
EXPLOSIVE CHARACTERISTICS

Explosive Composition	Sensitivity: Impact (2 kg wt)	Sensitivity: Pendulum Friction	Sensitivity: Heat Expl (5 sec)	Sensitivity: Bullet Impact	Brisance: Sand Test (gms)	Brisance: Shell Frag (% TNT)	Melt Temp (°C)	Detonation Velocity (M/sec)
Comp B 60% RDX 30% TNT 1% Wax	14" * 75 cm**	0	278°C	Rifle-15%	54.0	139	80°	7800 M/sec @ 1.59 g/cc
Tetryl 2, 4, 6 Tri- nitrophenyl- methyl-nitramine	8" * 26 cm**	0	257°C	Explosion-13% Partial-54% Burned-10%	54.2	121	130°	7850 M/sec @ 1.71 g/cc
Tetrytol Tetryl/TNT								
80/20	9" *	Slight	290°C	Rifle-30-50%	54.0	120 to 134	65°	7310-7385 M/sec
75/25	10" *	Slight	310°C	(Low order		(Varies with	90°	@ 1.6 g/cc
70/30	11" *	Slight	320°C	dependent upon		tetryl content)		
63/35	11" *	Slight	325°C	Tetryl content)				
Trinitro-toluene (TNT)	14" * 100 cm**	0	475°C	Rifle-4% (detonate-2% burn-2%)	47.5	100	81°	6700 M/sec @ 1.56 g/cc (cast)
Cyclonite (RDX) Cyclo-trimethylene Trinitramine	8" *	20	260°C	Rifle-100%	60.2		204°	8180 M/sec @ 1.65 g/cc

*Picatinny Arsenal Test
**Bureau of Mines Test

SECTION 3

MUNITION DEMILITARIZATION PROCESS FLOW

Processes employed by the CAMDS facility include thermal deactivation of explosives and propellants, chemical neutralization of nerve agents, incineration of mustard agents and thermal destruction of residual agent contamination on inert components and munition metal parts. The specific process flow varies with each munition category because of the variation in munition composition. However, only one type of munition and one type of agent will be processed in the CAMDS plant at one time. The plant will be adapted to a particular munition process by rearrangement or modifications of equipment between each demilitarization period. For all munitions except bulk items (bombs, ton containers and spray tanks), the process flow normally begins with the receipt and inspection of munitions in a barricaded holding area. Rockets, projectiles, mortars and mines are removed from their shipping containers manually in a general unpacking building and are placed on conveyors which carry them to processing areas. All munitions containing explosives or energetic materials enter a large steel pressure vessel designed to contain the effects of an accidental explosion of any agent-filled munition. Inside this explosive containment cubicle, computer controlled, automated machinery dismembers the munition and separates the explosive components from the chemical agent. The procedures employed and the form of the residue varies with each munition category. Explosives and rocket motors are conveyed to a direct fired rotary kiln where they are "deactivated" by burning under controlled conditions to preclude high order detonation. Inert parts fed to this deactivation furnace along with the explosives are also heated and retained at sufficiently high temperature to pyrolize any residual agent contamination. Trace quantities of vaporized chemical agent are pyrolized and oxidized in a direct fired afterburner associated with the furnace pollution control system.

Projectiles and mortars which are deburstered in the explosive containment cubicle, as well as non-burstered projectiles, are conveyed to a separate projectile disassembly facility where automated, computer controlled machinery extracts the burster wells from the projectile bodies thus exposing the chemical agent chamber. Nerve agents are pumped out of the shells and transferred to a separate agent destruction facility. Mustard agents are left in the opened shells.

All contaminated shell bodies are conveyed from the projectile drain system to a multi-chamber, semi-continuous hearth furnace in which mustard agent is boiled out of the shell bodies and burned and nerve agent projectiles are pyrolitically decontaminated by soaking at temperatures of 1000°F or greater. Trace quantities of agent leaving the furnace are thermally pyrolized and oxidized in an afterburner chamber. Exhaust

gases from both the explosive deactivation furnace and the metal parts decontamination furnace are chemically scrubbed and filtered to remove noxious combustion products to a level consistent with air emission standards.

Bulk items are processed in a manner similar to deburstered projectiles in a separate bulk item facility. Bombs and spray tanks containing nerve agents are drained, flushed with decontamination solution and heat treated in the metal parts furnace. The nerve agent is pumped to the agent destruction plant for treatment. Mustard ton containers are conveyed directly to the metal parts furnace where the container is opened to expose the agent; the agent is boiled out and burned; and the residual container is heat treated for decontamination.

Nerve agents are collected in storage tanks in a separate agent destruction facility which contains batch reactors for the chemical destruction of nerve agents. Agent GB is destroyed by reaction with sodium hydroxide in aqueous solution. Agent VX is destroyed by chlorinolysis in aqueous hydrochloric acid. The resulting acidic solution is neutralized with sodium hydroxide. All neutralized brine from the agent destruction plant is tested to certify agent detoxification before it is dried in steam-heated rotary drum dryers in a non-contaminated area of the plant. GB brine is certified by checking for five percent excess sodium hydroxide and VX brine is certified by conducting an enzymatic test. The residual salts are pelletized and packed in fiber drums. Scrubber solutions from the deactivation furnace and metal parts furnace gas scrubber systems and also dried on the rotary drum dryers.

All plant washdown solutions, including potentially contaminated personnel decontamination shower effluents, are collected in the agent destruction plant for certification and, if necessary, treated with caustic solution to assure decontamination. Washdown solutions are certified by checking for five percent excess sodium hydroxide/carbonate. These solutions are also subsequently dried on the drum dryers with the residual salts compacted and drummed. All residual salts from the CAMDS plant will be stored at Tooele Army Depot pending selection of a final disposal method. Metal parts, thermally decontaminated and certified agent-free, will be transferred to the Tooele Army Depot Property Disposal Office for sale as scrap.

This section contains schematic flow diagrams and a discussion of the specific steps involved in each disposal process. A more detailed description of the facility, including design and operating characteristics of each major item of process equipment, is contained in Section 4.

3-1 M55 Rocket, GB/VX (FIGURE 3-1)

Pallets of M55 rockets will be delivered to the CAMDS Munition Holding Area (MHA) by ammunition transport vans fitted with charcoal filters. The vans contain three pallets each with a total of 45 rockets. This is a sufficient quantity for 3 hours of operation at normal production rates.

Delivery of munitions to the site and movement of pallets within the site will not be permitted during an electrical storm. If visibility is less than 20 feet, chemical munitions will not be moved from Area 10 to the CAMDS site. Vehicles transporting chemical munitions will be driven at a safe speed which is consistent with weather and road conditions up to a maximum of 20 miles per hour.

The MHA consists of an L-shaped steel and earthen barricade in which the van will be parked. Each pallet of M55 rockets will be placed in a single pallet only rocket transport (SPORT) container before it is transported to the MHA. A 100 percent inspection of the SPORT through a detector sampling port will be performed at the MHA prior to movement of the individual transport container to the Unpack Area (UPA). A similar inspection will be performed in the UPA prior to opening of the SPORT for individual rocket processing. Over containers free of leakers will be transported one at a time from the MHA to that portion of UPA where non-leakers are processed. Two SPORTS containing rockets will be permitted in the UPA at one time during operations and overnight. SPORTS which indicate leakers are present will be transported from the MHA to the UPA where leaking munitions are processed.

Non-leaking rockets will be manually fed through a revolving munitions loading door and placed one at a time on a conveyor which introduces the rocket into the Explosive Containment Cubicle (ECC). The ECC vestibule separates the uncontaminated UPA from the contaminated inlet to the ECC. The revolving munitions loading door feed mechanism separates the UPA from the toxic ECC vestibule and prevents backflow of contaminated air to the operator area. Uncontaminated combustible dunnage resulting from the unpacking operation will be carried to the Dunnage Incinerator (DUN) for disposal by burning. Ash from the DUN will be disposed of in the Tooele South Area as landfill.

All SPORT containers which contain leaking rockets will be down loaded in the ECC vestibule section of the UPA. Operators working in this area will wear Level A protective clothing. The cover will be removed from the transport container and the rockets taken out one at a time and manually placed on a conveyor which introduces the rocket into the ECC. Contaminated dunnage will be retained in the SPORT and

then eventually disposed of in the Metal Parts Furnace (MPF). The SPORT will be externally decontaminated, tagged as containing contaminated material, and then moved to the Bulk Item Facility (BIF) downloading room where the dunnage will be flushed with decon and monitored. The surface decontaminated dunnage will eventually be loaded in a dunnage processing fixture for processing through the MPF. Production control personnel will control the storage location and accountability through destruction of the dunnage. The empty SPORT will be internally and externally deconned, inspected, and then returned to service.

The rocket input conveyor enters the ECC through a munition loading door. Inside the cubicle, the rocket is conveyed into position in the Rocket Demil Machine (RDM). In this machine, the rocket warhead is tightly held between two hydraulically operated clamps while two hydraulically operated punches are driven through the warhead in such a manner that the central burster is not touched. The agent contents of the rocket are then drained through the clamping fixture from the holes created by the punches into an agent measuring tank which verifies that the warhead has been completely drained. The rocket is then released from the clamp and moved further into the machine where it is submerged in a tank of aqueous solution. Submerged in the solution, the rocket is then cut into seven pieces by the action of six circular cold saws. The cut up rocket pieces are then raised from the solution, the cubicle discharge door opens, a discharge conveyor enters the ECC and is positioned under the rocket pieces. The pieces are placed onto the conveyor and are removed from the ECC. When the pieces have been withdrawn, the ECC munition inlet door is opened and the next rocket is inserted into the system.

Outside the ECC, the rocket pieces are deposited in a specific sequence onto a conveyor which carries them to the CAMDS Deactivation Furnace System (DFS). The explosive portions of the rocket are burned in the DFS and any residual agent is incinerated in an afterburner. Decontaminated metal parts and unburned fiberglass from the rocket shipping tube are discharged from the DFS at a temperature of 1000°F. The discharged pieces are carried on an electrically heated conveyor which will insure retention of the pieces at 1000°F for a period of time necessary for thermal destruction of residual agent traces. The time required to assure acceptable decontamination will be determined during the initial test phase. The scrap is then deposited in an enclosed container for removal to a storage or burial point.

GB withdrawn from the M55 rocket in the ECC is transferred from the measuring tank to the Agent Destruction System (ADS) through a double-walled pipe designed to contain any accidental leakage in the agent transfer line. The agent is collected in a storage tank inside the ADS toxic cubicle. The toxic cubicle contains all reactors, pumps, holding

vessels, and other equipment used for the neutralization of GB and for the acidic chlorination of agent VX. GB is neutralized by reaction with 18% sodium hydroxide solution in agitated 2000-gallon batch reactors. The residual brine solution is held in the reactor from which a sample of the solution is withdrawn and certified agent-free by analyzing for 5 percent excess sodium hydroxide. This solution is then transferred to brine holding tanks which feed two rotary drum dryers in the ADS. Dried salts produced by the drum dryers are collected and, where necessary, compressed into pellets. The salts are then placed in drums and shipped to a storage building within the Tooele Army Depot South Area.

The rocket sawing operation inside the ECC is performed in a liquid cooling bath. In the case of GB-filled rockets, the bath is a 10 percent solution of sodium carbonate. This bath will provide decontamination of any residual GB agent which is released under the surface of the bath. The sawing operations generates metal parts, pieces of the fiberglass shipping tube, and pieces of explosive and rocket propellant. In addition, explosive and rocket propellant are dissolved to some extent in the solution. Periodically during each shift, a portion of the saw tank mixture is pumped through bag filters located in the ECC housing and into a decon hold tank. At the same time, an equivalent portion of decon is pumped from the hold tank to saw tank. The filter removes suspended solids. Pressure drop is the method used for determing when the bag filters need replacement. Pressure transducers are employed which permit monitoring of bag filter pressure in the control module. If filters require replacement during the shift (not expected), the filter bags will be replaced by an operator through a glovebox and placed in plastic bags without entering the ECC housing. Routine filter replacement will be accomplished at the end of the shift and the filter bags will be processed through the Deactivation Furnace System (DFS). Personnel in level A protective clothing would place the bagged filter on the DFS input conveyor for processing through the DFS. At the end of each shift, the solution in the decon hold tank is checked for pH and is then pumped to the Explosive Treatment System (ETS). In the ETS, the solution is passed through tanks packed with activated carbon to adsorb any dissolved explosive materials. The resulting brine solution, free of explosive components, is then pumped to waste neutralization tanks in the ADS for certification and subsequent processing through the rotary drum dryers. If required, salts from this operation will also be pelletized. Dried salts will be drummed and transported to onsite storage facility.

In the current plan, the CAMDS facility at Tooele Army Depot will dispose of M55 GB-filled rockets. However, there are no plans at this time to process VX-filled rockets. The processing technique varies slightly in the case of VX rockets in that the RDM sawing operation is conducted under water rather than decon solution. Available decon solutions

for VX are corrosive to the RDM machine, or in the case of alcoholic caustic, are unsuitable for processing aluminum rockets and incompatible with the ADS drying facility. When processing VX rockets in the ECC, water from the saw tank will be pumped out of the ECC through filters and into a neutralization tank located within the housing of the ECC. In this tank, the contaminated water will be mixed with a solution of calcium hypochlorite to neutralize residual VX. After neutralization, the hypochlorite solution will be certified agent-free and will then be pumped through the ETS for processing similar to the procedure followed for GB rocket demilitarization.

The sodium carbonate solution used in the RDM when processing GB rockets will be prepared in the ETS. The calcium hypochlorite solution used during the processing of VX rockets will be prepared in the CAMDS Central Decon System (CDS), located in another facility, and will be pumped to the ETS to provide necessary solutions to the ECC on demand.

Although the CAMDS facility is intended to provide high capacity demilitarization of non-leaking munitions, it will have a capability to handle leaking M55 rockets which have been encapsulated. Rockets which have been provided with end caps to control leakage from the ends of the shipping container can be processed through the RDM without changes in the process or equipment. Rockets which have been packaged in steel tubular containers (pigs) will have to be removed from the container before insertion into the ECC. This operation will be performed manually by personnel in full protective clothing (level A protection) inside the ECC vestibule area where leaking munitions are processed. When processing steel containers, the container will be decontaminated chemically before removal in a plastic bag. The treated steel containers in a 3X condition will be appropriately tagged and either returned to the depot for reuse or held in open storage until they can be processed in the Metal Parts Furnace.

M55 ROCKET

GB/VX

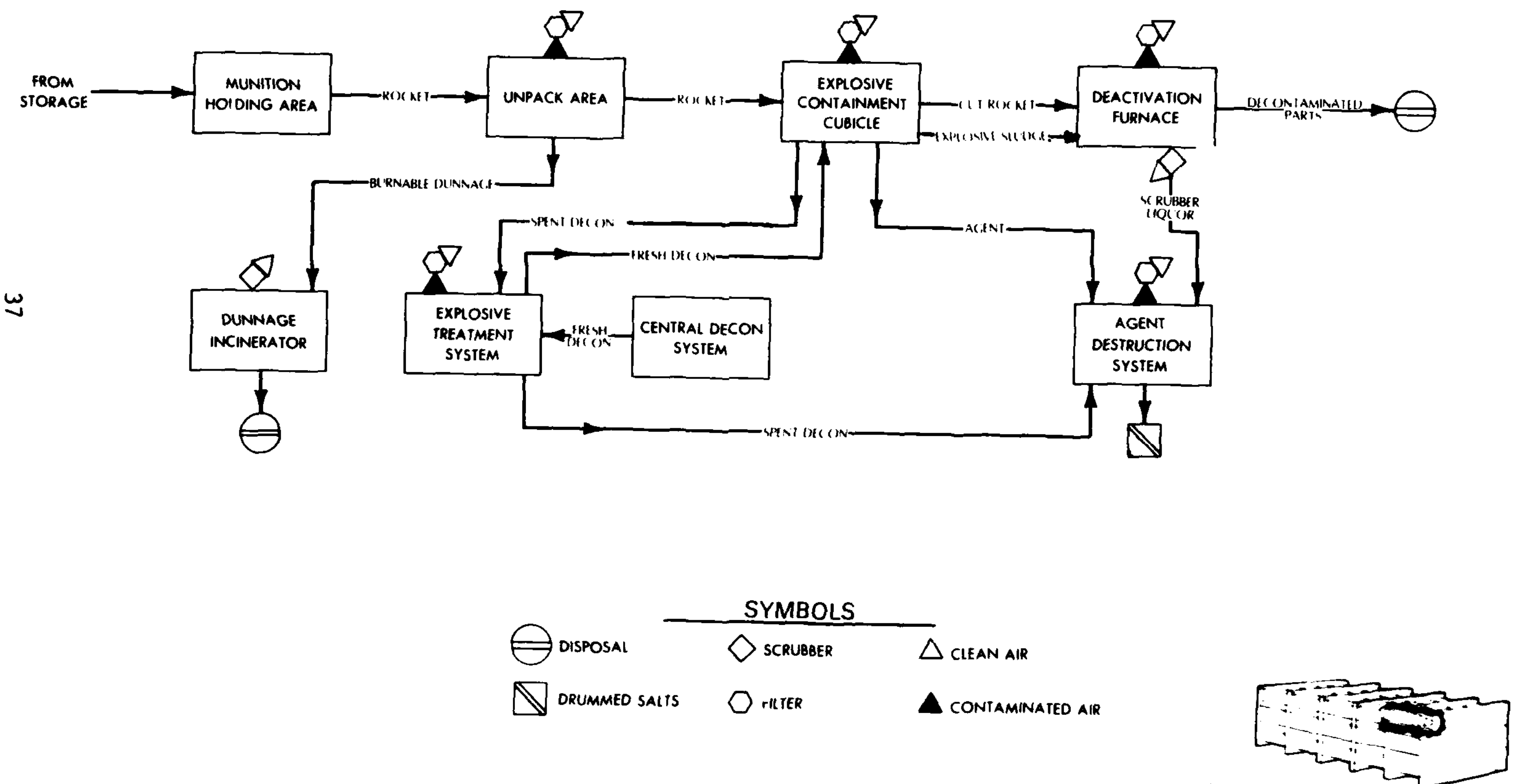


Figure 3-1 M55 Rocket, GB or VX, Demilitarization Process Flow

AUG 75

3-2 PROJECTILES/CARTRIDGES, GB OR VX, WITH BURSTERS (FIGURE 3-2)

The only burstered munition in this class located at Tooele Army Depot is the GB-filled 105mm M360 cartridge. This round is packaged two to a box, twelve boxes per pallet. The boxes will be visually inspected at the storage igloo for evidence of leakage. The non-leaking boxes will then be transported to the CAMDS site with the munition transport van. The van will contain 14 pallets or 336 rounds, sufficient for 6½ hours of operation. The van will be parked in the barricaded Munition Holding Area. Every effort will be made to move vans during daylight hours. Thus, two vans may be in the barricaded area at any time. However, the total amount of explosives in the Munition Holding Area at any one time will not exceed the explosive limit for the area established as 4,000 lbs of explosives. In the Munition Holding Area, the boxes are again inspected for external evidence of agent leakage. If leakage is discovered or suspected, the pallet will be disassembled by operators in level A protection. Suspected contaminated boxes will be placed in double plastic bags and will be carried separately to the Unpack Area (UPA) for processing as leaking rounds.

Pallets which show no evidence of leaking are taken by forklift truck from the Munition Holding Area to the UPA. In the UPA, the boxes are removed from the pallets and opened by personnel wearing level B protective clothing inside the Explosive Containment Cubicle (ECC) vestibule section of the UPA. The opened box will be sniffed with a GB agent detector as soon as it is opened to insure that it does not contain leaking rounds and is not contaminated. Assuming that the contents of the box are not contaminated, the propelling charge and cartridge case will be left in the original packing container, removed from the unpack airlock, and returned to storage. The 105mm projectile is loaded manually and placed on a conveyor for introduction to the Explosive Containment Cubicle (ECC). If agent is discovered during unpacking operations, the munitions will be externally decontaminated, fed to the ECC and processed as indicated below. Dunnage will be packaged in drums for subsequent disposal in the metal parts furnace during off shifts. The propellant and the cartridge case with primer will be burned in the deactivation furnace during off shifts.

Inside the ECC, the projectile is automatically positioned in the Projectile Demil Machine (PDM). This machine clamps the projectile in place and cuts off the fuze with a circular cold saw. The fuze is deposited on a discharge conveyor which removes it to a position near the ECC discharge door. The projectile is then moved further into the machine and positioned to extract the burster. The burster is forced out of the projectile by differential air pressure and cut into two pieces with a circular saw. At the conclusion of the sawing operation, the ECC exit doors open, and the cut bruster and fuze are removed by conveyor to the rotary Deactivation Furnace System (DFS). A separate conveyor withdraws the deburstered projectile.

In the DFS, the fuze and cut burster sections are burned and the metal parts are passed through the furnace. The furnace off-gases are passed through an afterburner and a scrubbing system to destroy any residual traces of vaporized agent and to remove noxious products from the gas stream before discharge to the atmosphere. The inert pieces are conveyed through the DFS and deposited on a heated conveyor to provide additional residence time at 1000°F to insure decontamination.

Periodically, the cutting solutions used to lubricate the saw blades during cutting of the fuze and reduction of the burster will be pumped from the ECC through filters located in the ECC housing to remove metal particles and then to a decon hold tank also located in the ECC housing. The solution is then pumped from the hold tank to the Explosive Treatment System (ETS) where it passes through charcoal absorption columns to remove dissolved explosives. It is then pumped to waste neutralization tanks in the Agent Destruction System (ADS) for eventual drying on the rotary drum dryers. Sludge filtered from this mixture in the ECC will periodically be removed by an operator through a glove box, placed in a plastic bag, and fed to the DFS for thermal destruction. As in the case with rocket demil, if sludge transfer lines become plugged, they will be disassembled, deconned and burned.

During normal operations, no agent will be released in the ECC during processing of the 105mm projectiles. The burster extraction processes do not open the agent cavity. However, in the event a leaker is discovered in the ECC, as indicated by TV observation, the demilitarization operation will be continued until the burster is removed and cut into pieces. At this time, however, operators in full level A protective clothing will enter the ECC and will place a mechanical plug or cap over the open end of the projectile. The projectile will be externally decontaminated. Decon will be added to the saw solutions and these solutions will be pumped to a decon tank located in the ECC housing. The solutions will be retained in this tank until they are sampled and certified to be decontaminated. The closed projectile will be conveyed to the Projectile Disassembly Facility (PDF) where it will be manually loaded into the projectile drain system and the cap removed. The fuze and burster will be decontaminated with caustic solution inside the ECC and will then be discharged and processed in the normal fashion through the DFS. The contaminated machinery within the ECC will be chemically decontaminated.

In the normal operations, the projectiles exit the ECC without contamination and are conveyed automatically to the Projectile Pull and Drain Machine (PPD) located in the PDF. In this machine, the open deburstered projectile, in a vertical position, is probed to assure the explosive

has been removed. The steel burster well is then extracted mechanically and an agent removal tube is inserted into the projectile. The agent fill is removed by a suction pump and conveyed to a storage tank in the ADS. (Tests indicate draining efficiency will be greater than 95 percent.) The burster well is passed through a decon bath. The drained projectile is then placed on a special conveyor which will move it in the vertical position through a ventilated conveyor tunnel to the Metal Parts Furnace (MPF). The burster well is conveyed to the MPF by a separate belt conveyor. In the MPF area, the projectile is loaded onto a tray which has a capacity of containing 70 105mm projectiles. Conveyance and loading of the trays will all be done by remote control under operator supervision. Burster wells will be discharged to a metal basket. When the munition tray is full, it will be moved automatically through the MPF where residual agent is volatilized from the projectiles and burned in an afterburner operating at a temperature/residence time adequate to destroy any agent. The projectile bodies are raised up to 1000°F in the furnace and held at the required temperature for a period up to 1 hour to assure detoxification of any residual agent. Off-gases from the furnace and afterburner are passed through a venturi scrubber and a packed column absorber to remove noxious gases. The decontaminated metal parts are cooled, then loaded on open trucks for transport to an open storage pad within the Tooele Army Depot South Area pending eventual sale as scrap.

GB collected in the agent storage tanks within the toxic enclosure of the ADS will be destroyed by reaction with sodium hydroxide in a manner identical to that employed with GB-filled M55 rockets. The GB brine will be certified agent-free by checking for excess caustic and pH. VX brine will be certified agent-free by conducting an enzymatic test. The brine from the destruction plant will be dried on rotary drum dryers and the residual salts will be pelletized as required and packaged in fiber drums for onsite storage. Spent scrubber solutions from the MPF and DFS will be pumped to the ADS for certification and subsequent drying on the rotary drum dryers. Residual salts from these solutions will also be packaged and stored similarly to the neutralized GB salts.

PROJECTILES/CARTRIDGES

GB/VX WITH BURSTERS

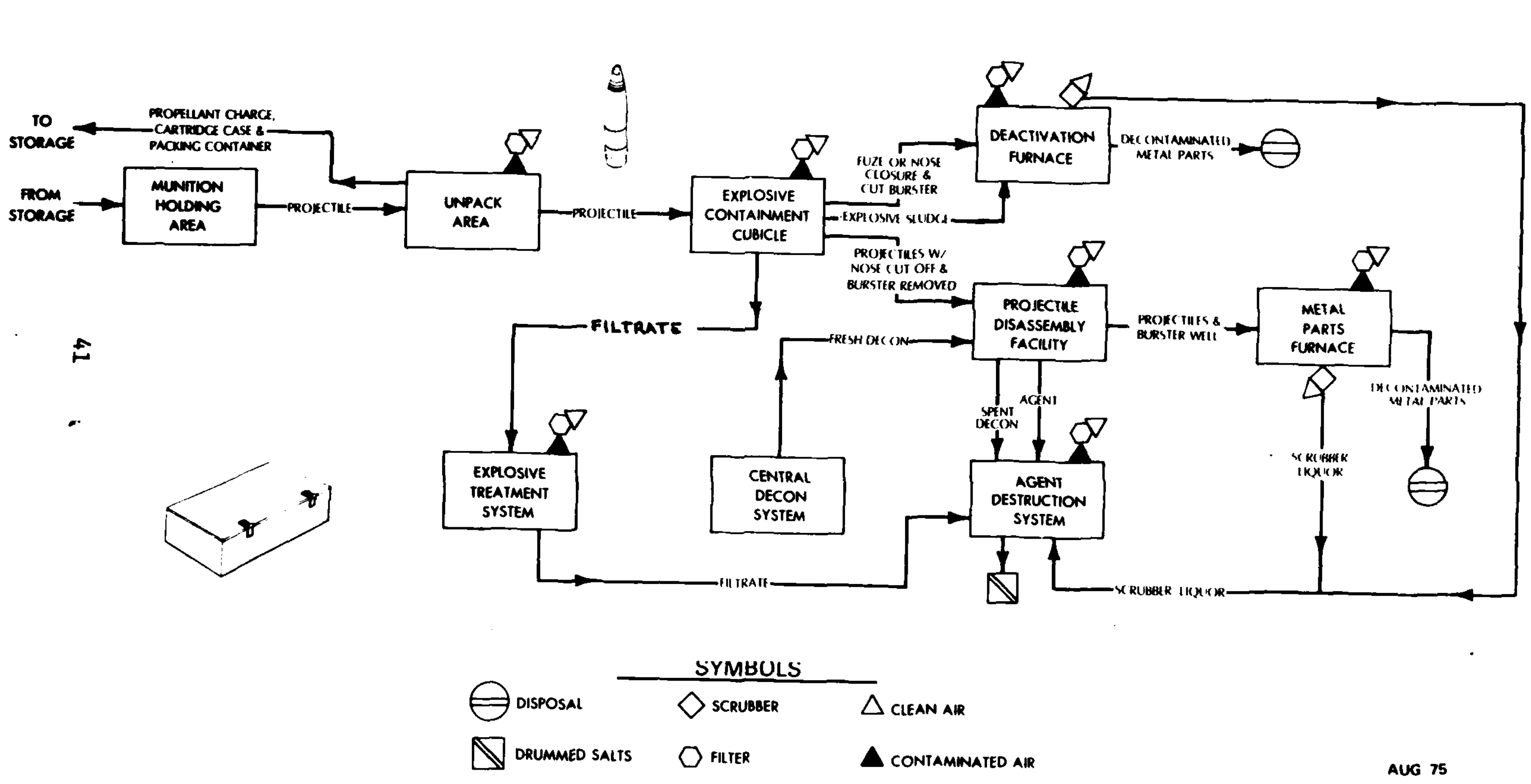


Figure 3-2 Projectiles/Cartridges, GB or VX, with Bursters, Demilitarization Process Flow

3-3 PROJECTILES/CARTRIDGES, GB OR VX, WITHOUT BURSTERS (FIGURE 3-3)

Tooele Army Depot stocks consist of the following non-burstered projectiles:

105mm M360 (GB)	155mm M122 (GB)
155mm M121 (GB)	8 inch M426 (GB)
155mm M121A1 (GB)	155mm M121A1 (VX)

The palletized munitions are taken from the storage igloo to the Munition Holding Area (MHA) by the ammunition van. 105mm projectiles will be conveyed either in 24 round pallets or in 15 round pallets, 14 and 24 pallets per van respectively. 155mm projectiles will be packaged 8 rounds per pallet and 20 pallets per van. 8 inch projectiles will be packaged 6 rounds per pallet and 20 pallets per van. (The current plan does not require processing of 8 inch projectiles although the system does have this capability.) These munitions are temporarily held in this area until they are required for processing. The rounds are inspected externally for agent leakage at the igloo and again at the MHA by personnel in level A protective clothing. Leaking rounds will not be moved to the CAMDS site under this plan. If leaking rounds are discovered in the MHA, they will be segregated and externally decontaminated by personnel in level A protective clothing. The rounds will then be placed in double plastic bags and carried by closed truck to the Projectile Disassembly Facility (PDF) where they will be manually removed and placed in the Projectile Pull and Drain Machine (PPD). The packing material will be processed through the Metal Parts Furnace (MPF).

Non-leaking, palletized rounds are taken from the MHA to the Unpack Area (UPA) with a fork lift truck. In the UPA, the rounds are removed from the pallet and placed on the Explosive Containment Cubicle (ECC) by-pass conveyor which carries them to the Projectile Disassembly Facility to be processed in the Projectile Pull and Drain Machine. The pallets are sent to the Dunnage Incinerator for burning and the resulting ash is sent to disposal.

In the Projectile Pull and Drain Machine, the nose closure is removed from the projectile and the burster well is extracted. Agent is removed and sent to the Agent Destruction System (ADS). The burster well is passed through a decon bath. Decon is supplied by the Central Decon System (CDS). The spent decon is sent to the ADS for detoxification and drying. The empty projectile, the burster well and the nose closure are sent to the Metal Parts Furnace for decontamination. Scrap metal parts from the MPF are sent to disposal.

The agent is neutralized in the ADS. The resulting brine and the brine from the Metal Parts Furnace scrubber are also dried in the ADS. The salts produced during all drying operations are placed in drums and sent to storage.

PROJECTILES/CARTRIDGES

GB/VX WITHOUT BURSTERS

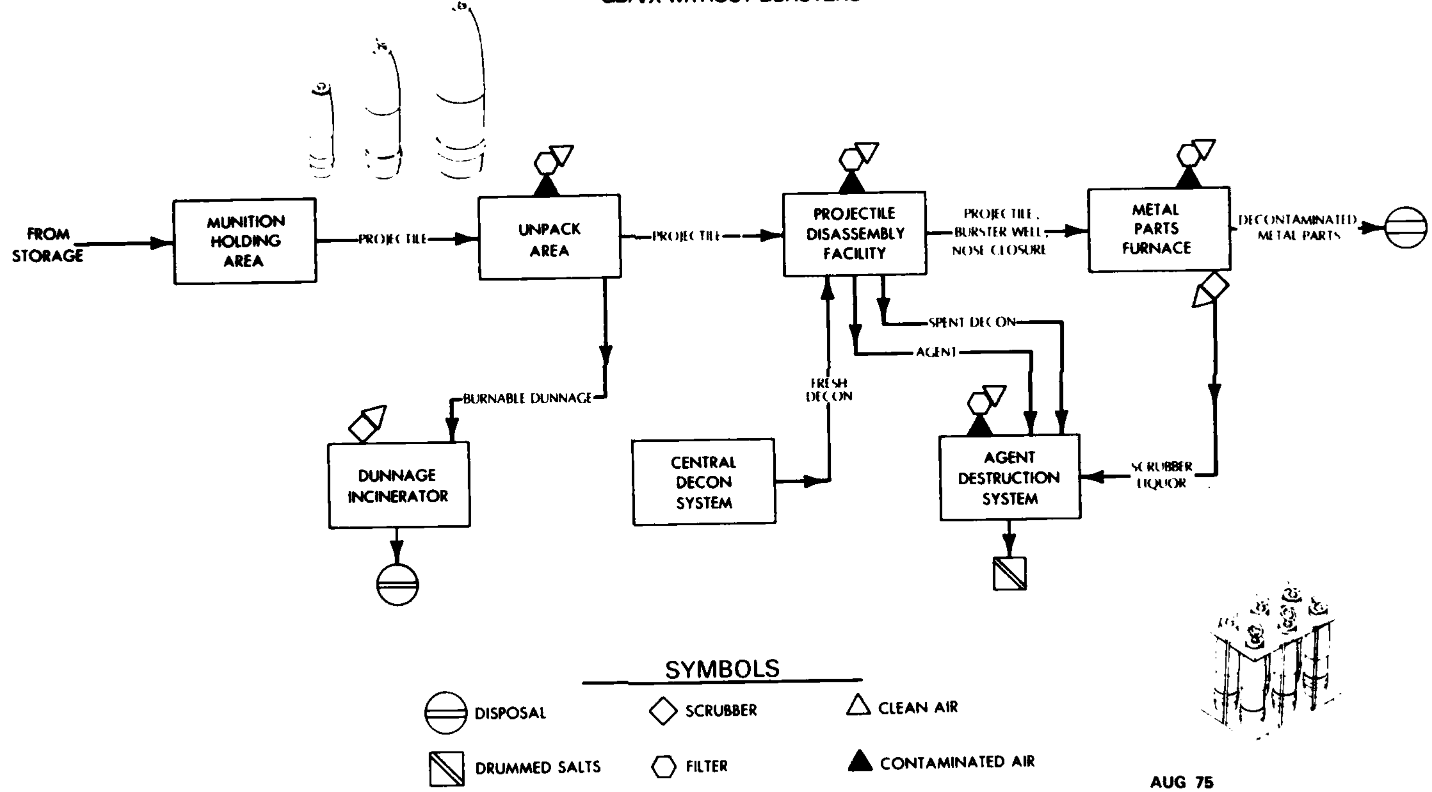


Figure 3-3 Projectiles/Cartridges, GB or VX, without Bursters, Demilitarization Process Flow

3-4 PROJECTILES, MUSTARD, WITH BURSTERS (FIGURE 3-4)

Tooele Army Depot stocks consist of 155mm M104 and M110 mustard projectiles with bursters. These projectiles are currently stored unpalletized and will be placed in non-absorbent, reusable steel trays for transport by ammunition transport van from the igloo to the Munition Holding Area. The projectiles are inspected externally for agent leakage both at the igloo and at the Munition Holding Area. Leaking rounds will not be transported to the CAMDS site under this plan. If leaking rounds are discovered at the Munition Holding Area, they will be externally decontaminated, packaged in double plastic bags and placed in the Unpack Area airlock for processing at the end of the shift.

The munitions are taken from the Munition Holding Area to the Unpack Area with a fork lift truck. In the Unpack Area, the projectiles are removed from the reusable tray and placed on a conveyor where they are fed one at a time to the Explosive Containment Cubicle (ECC).

In the ECC, the Projectile Demil Machine (PDM) cuts the nose closure off the projectile and extracts the burster from the burster well. The burster is cut up and fed to the Deactivation Furnace System (DFS) along with the nose closure. The decontaminated metal parts coming out of the DFS are sent to disposal. The projectile, with nose cut off and burster removed, is conveyed to the Projectile Disassembly Facility (PDF) to be processed in the Projectile Pull and Drain Machine (PPD). The explosive sludge resulting from the cutting operation is filtered in the ECC housing and then sent to the Explosive Treatment System (ETS).

If leaking rounds are discovered in the ECC by visual observation with the TV monitor, the PDM operation will be continued until the burster is extracted. The operation will then be stopped and operators in level A protective clothing will enter the ECC to plug the projectile and decon all contaminated items. The operation will then be continued to cut the bursters and discharge all components from the ECC.

In the PPD, the burster well is extracted from the projectile and passed through a decon bath. The mustard-filled projectile and the burster well are conveyed to the Metal Parts Furnace (MPF). In the MPF, the mustard is incinerated. The decontaminated metal parts leaving the MPF are sent to disposal.

In the ETS, the solution is passed through tanks packed with activated carbon to adsorb any dissolved explosive material. The resulting explosive-free solution is sent to the Agent Destruction System (ADS) waste neutralization tank for detoxification certification and drying. The MPF and DFS scrubber solutions, certified agent-free by chemical analysis, are also sent to the ADS brine hold tanks for drying. The salts produced during the ADS drying operation are placed in drums and sent to storage.

PROJECTILES
MUSTARD, WITH BURSTERS

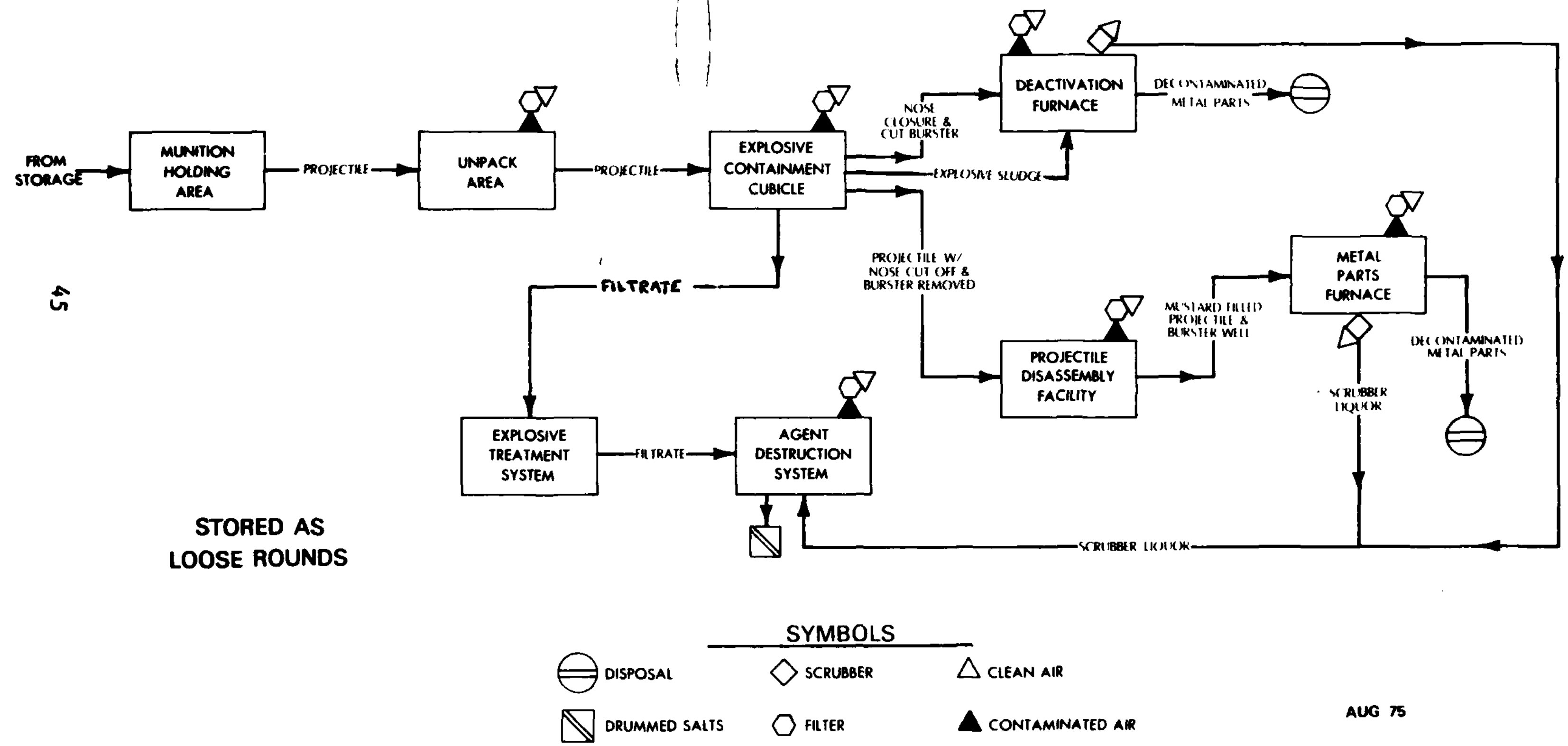


Figure 3-4 Projectiles, Mustard, with Bursters, Demilitarization Process Flow

3-5 4.2 INCH MORTAR CARTRIDGE, MUSTARD (FIGURE 3-5)

The 4.2 inch mortar cartridge is packaged two to a box, 20 boxes per pallet. Pallets are taken from the storage igloo to the Munition Holding Area (MHA) by the ammunition van at a rate of seven pallets per van. The munitions are temporarily held in the MHA until they are required for processing. The boxes are inspected externally for leakage both at the igloo and at the MHA. Leaking boxes will not be transported to the MHA. However, if leakers are discovered there, the pallets will be downloaded by personnel in level A clothing, contaminated boxes will be placed in double plastic bags, and will then be taken to the Unpack Area (UPA) airlock to be processed as leakers by personnel in level A clothing.

During normal operations, the mortars are taken from the MHA to the UPA with a fork lift truck. Within the Explosive Containment Cubicle (ECC) vestibule section of the UPA, the ignition cartridge, the propelling charge, obturator, and base plate are removed from the mortar by operators in level B clothing and returned to storage. When processing a leaker, the components will be chemically or thermally decontaminated prior to disposal. None of these items will be salvaged for reuse. The round is placed on a conveyor where it is fed to the ECC. The burnable uncontaminated dunnage is sent to the Dunnage Incinerator (DUN) for burning and the resulting ash is sent to disposal.

In the ECC, the fuze burster assembly is removed from the mortar by the Mortar Demil Machine (MOR). The burster is then unscrewed from the fuze and the two items are sent to the Deactivation Furnace System (DFS) for destruction by burning. The deactivated metal parts components are sent to disposal. The mortars less fuze and burster are sent to the Projectile Disassembly Facility (PDF) to be processed in the Projectile Pull and Drain Machine (PPD). In the event a liquid leaker is discovered in the ECC after the burster and fuze are removed, as indicated by TV observation, the operation will be stopped. Personnnel in level A clothing will enter the ECC, plug the round opening and decon all external contamination. The operation will then be resumed.

In the PPD, the burster well is extracted from the round and passed through a decon bath. The mustard-filled round, in a vertical position, and the burster well are conveyed to the Metal Parts Furnace (MPF). The mustard is burned out of the cartridge in the MPF and destroyed by incineration. The decontaminated components are sent to disposal. Incineration products are removed from the furnace gases by a caustic scrubbing tower and a venturi scrubber.

The brines from the MPF and DFS scrubbers are certified agent-free by chemical analysis and sent to the brine holding tanks in the Agent Destruction System (ADS). The brine is dried on rotary drum dryers and the salts resulting from all drying operations are placed in drums and sent to storage.

4.2" MORTAR

MUSTARD

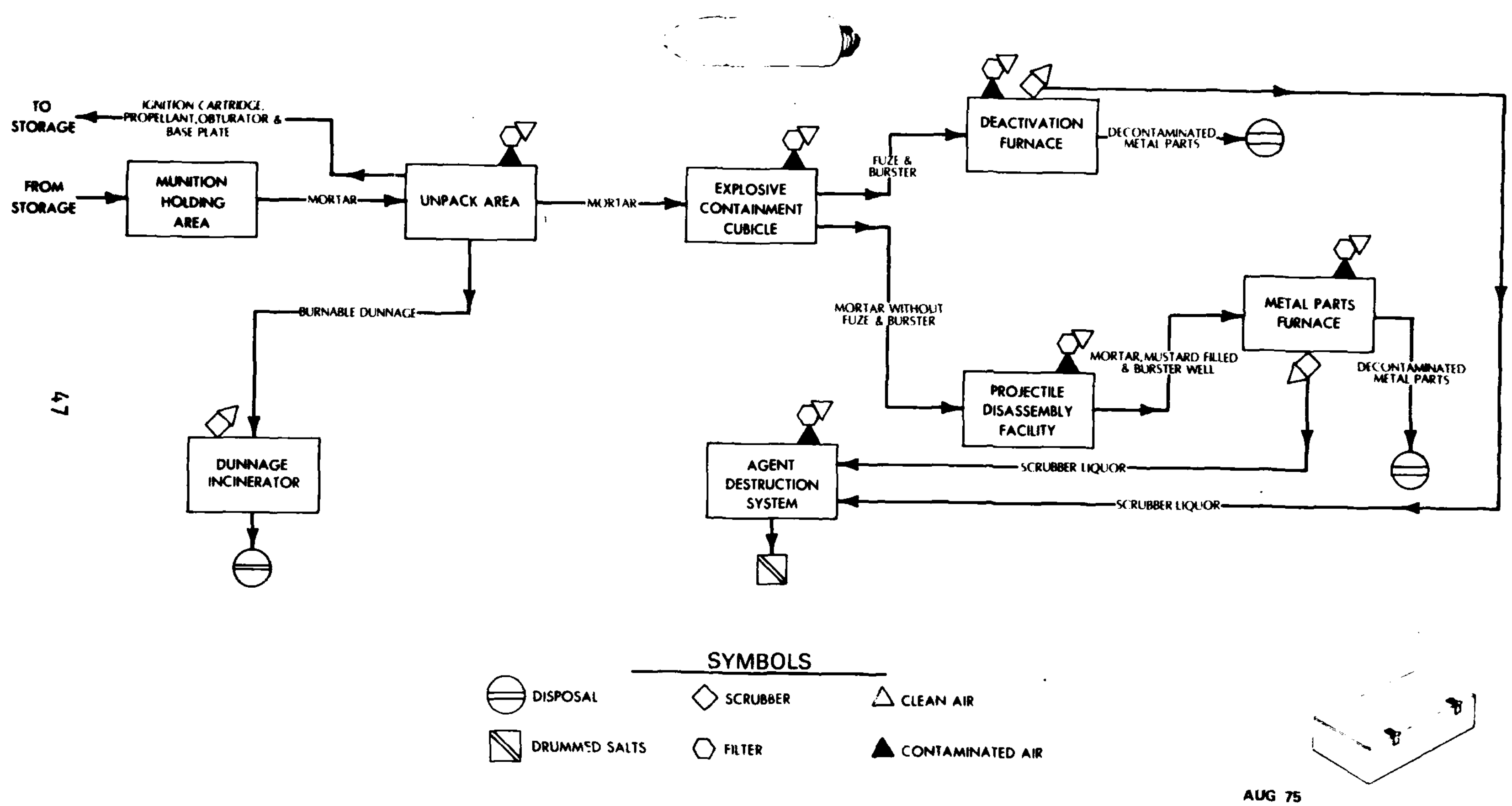


Figure 3-5 4.2" Mortar, Mustard, Demilitarization Process Flow

3-6 M23 MINE, VX (FIGURE 3-6)

The M23 mine is packaged three mines to a drum and 12 drums to a pallet. Pallets of mines are taken by ammunition transport van from the storage igloo to the Munition Holding Area (MHA) at a rate of seven pallets per van. The mines are temporarily held in this area until they are required for processing. The drums are inspected externally for possible agent leakage at the igloo and at the MHA. Leakers discovered at the MHA will be externally decontaminated, placed in double plastic bags, carried by closed truck to the Unpack Area (UPA) airlock to be processed as leakers.

The drums are taken from the MHA to the Unpack Area with a forklift truck. The drums are opened and inspected for leakage within the Explosive Containment Cubicle (ECC) vestibule section of the UPA by personnel in level B protective clothing. The mines are removed and placed on a conveyor where they are fed one at a time to the Explosive Containment Cubicle (ECC). The burnable, non-contaminated dunnage is sent to the Dunnage Incinerator (DUN) and the resulting ash is sent to disposal. The activator, fuze and storage drum are sent to storage. In the event leakers are discovered in the UPA, the mines will be externally decontaminated before processing to the ECC. The drum and all components will be decontaminated with hypochlorite solution. Explosive components will be destroyed in the Deactivation Furnace System (DFS). Dunnage and drums will be sent to the Metal Parts Furnace (MPF) for thermal decontamination.

In the ECC, the mine is placed in the Mine Demil Machine (MIN) where it is punched and drained. The mine body will be rinsed with either decon solution or water. The necessity and efficiency of a decon rinse will be assessed during the initial test phase of this process. The agent is sent to the Agent Destruction System (ADS) and the mine body, burster, and booster are sent to the DFS. The rinse solution is pumped to a neutralization tank in the ECC housing for blending with hypochlorite if necessary. The solution is periodically pumped to waste neutralization tanks in the ADS.

In the DFS, the explosive materials and any residual agent in the mine are burned. The decontaminated metal parts are sent to disposal.

The agent drained from the mine is detoxified in the ADS. The resulting brine, mine rinse solutions, and brine from the DFS scrubber are certified agent-free by enzymatic analysis before transfer to brine storage tanks in the ADS and subsequent drying on the ADS drum dryers. The salts produced during all drying operations are placed in drums and sent to storage.

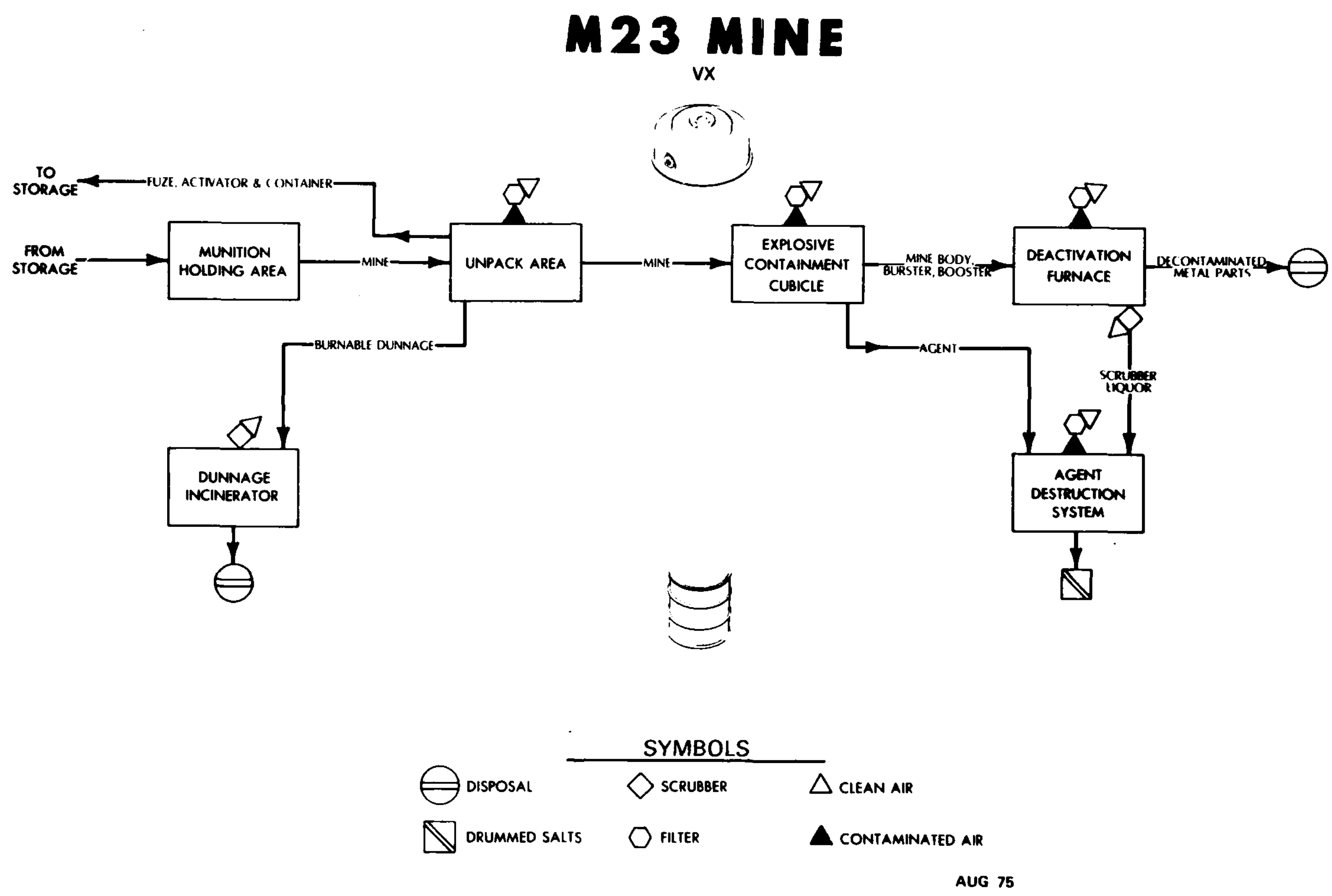


Figure 3-6 M23 Mine, VX, Demilitarization Process Flow

3-7 BULK ITEMS, GB OR VX (FIGURE 3-7)

Bulk items include GB-filled bombs, VX-filled spray tanks, and ton containers of GB, VX and HD. Under this plan, only VX ton containers and MC-1 GB-filled bombs will be processed in the Bulk Item Facility (BIF) to verify plant operability. The flow process for mustard ton containers is described in Section 3-8.

MC-1 GB bombs are conveyed from the storage site to the BIF on pallets containing two bombs each within a closed ammunition transport van. No more than ten bombs will be required during a one-shift operation; however, as many as twelve pallets may be moved at one time and temporarily stored in the BIF holding room. The bombs are inspected for leakage in the storage area and again at the BIF prior to off-loading the van. Leakers will not be purposely transported to the CAMDS site under this plan, and leakers are not expected to develop during transport to the CAMDS site. If a leaker is discovered at the BIF, it will be externally decontaminated by personnel in level A protective clothing according to approved SOPs and will be immediately placed in the airlock of the BIF for processing.

During normal operations, the pallets of bombs are removed from the transport van by fork lift truck and placed in the holding area of the BIF. The bombs are placed one at a time in the drain fixture within the toxic cubicle of the BIF by personnel in level A protective clothing. A drain/vent hole is drilled in the bomb by remote control and the agent is removed by a suction pump. The agent is pumped directly from the BIF to the Agent Destruction System (ADS) for neutralization. The bomb is then rinsed with decon solution and the resulting spent brine is transferred to the waste neutralization tanks in the ADS. The drained decontaminated bomb is externally decontaminated by personnel in level A protective clothing and removed from the toxic cubicle for subsequent transfer by fork lift truck to the Metal Parts Furnace (MPF). The bomb casing is then thermally decontaminated at 1000°F in the MPF and carried by truck to a metal parts storage area. Non-contaminated bomb pallets will be returned to the storage area for reuse or will be burned in the Dunnage Incinerator (DUN). All contaminated parts will be burned in the MPF.

VX ton containers will be transported from the storage point to the BIF on a flat bed trailer at a rate of five ton containers per load. The ton container is inspected for leakage prior to removal from the storage point, and no leaking items will be transferred to the CAMDS site. At the BIF area, the containers are removed one at a time from the transport trailer to the BIF holding area using a fork lift truck with a boom attachment. The containers are transferred one at a time to the agent drain area by personnel in level A protective clothing. The agent contents are removed by a suction pump and transferred to the ADS for neutralization.

The ton container is then filled with decon solution and drained. The spent decon is transferred to the waste neutralization tanks in the ADS for certification prior to drying. The drained ton container is then deconned externally, removed from the BIF, and conveyed by fork lift truck to the MPF where it is decontaminated by heat treatment at 1000°F. The decontaminated metal parts are sent to storage pending eventual disposal as scrap.

GB and VX removed in the BIF are detoxified by processes described earlier in this plan. After analysis and certification that they are agent-free, the neutralized solutions, brine from the MPF caustic scrubber, and the waste decon solutions from the BIF are all dried on drum dryers located within the ADS facility. The salts produced in the drying operation are placed in drums and the drums are sent to storage.

The decontamination solution used for GB is sodium hydroxide. This is prepared in the ADS, stored in the Central Decon System (CDS), and pumped as required to the BIF. Calcium hypochlorite solution, the decontaminant used for VX, is prepared in the CDS and pumped directly to the BIF.

BULK ITEMS

GB/VX

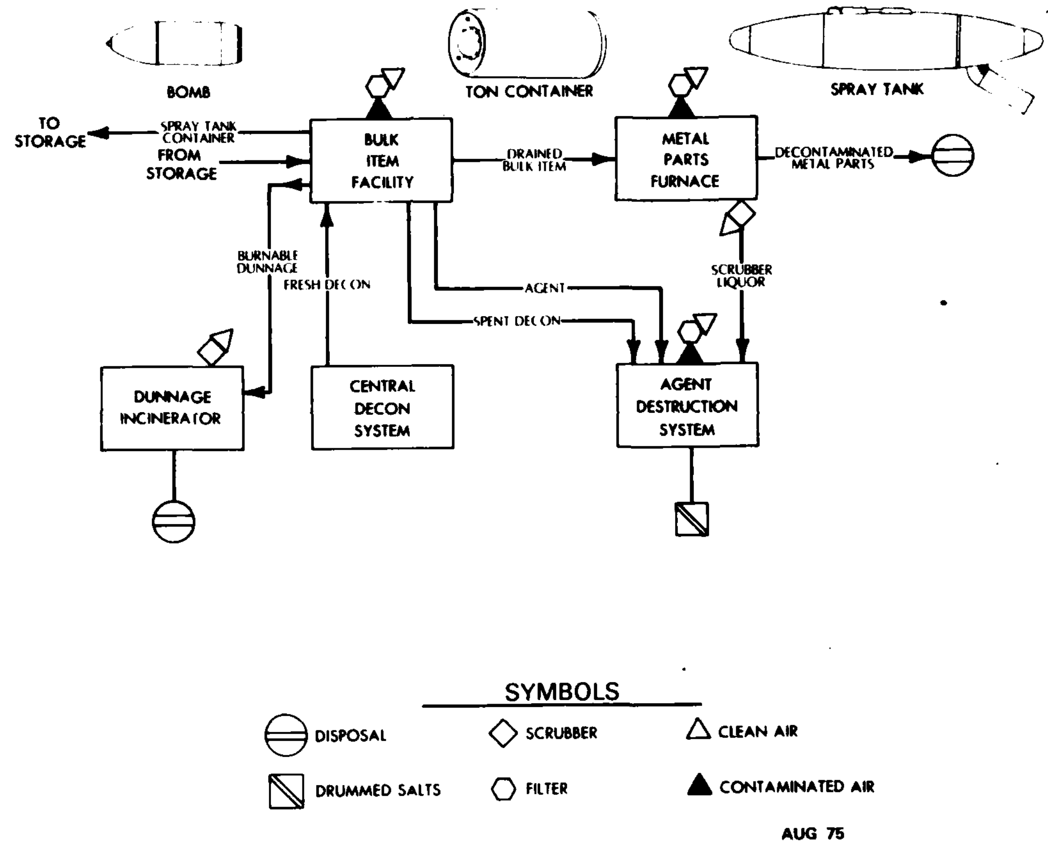


Figure 3-7 Bulk Items, GB or VX, Demilitarization Process Flow

3-8 TON CONTAINERS, MUSTARD (FIGURE 3-8)

Mustard ton containers will be transported from the storage area to the Metal Parts Furnace (MPF) on a flat bed truck at a maximum rate of six containers per load. The processing cycle is 4 hours per container so only two items will be processed during a normal day of operation. During warm weather, the containers will be transferred by a fork lift truck from the transport vehicle directly to the MPF. During cold weather, the containers will be placed in the holding area of the Bulk Item Facility (BIF) to warm before transfer to the MPF.

In the MPF, holes are punched in the ton container and the mustard contents are volatilized and burned. The container and residual ash are decontaminated in the furnace by heat treatment at 1000°F. The container is then cooled and transported by truck to a storage area pending disposal as scrap. The mustard incineration products, with the furnace flue gas, are scrubbed in a caustic scrubber system in the MPF. The scrubber brine is periodically certified agent-free by chemical analysis and sent to the drum dryers in the Agent Destruction System (ADS) for salt recovery. Dried salts are placed in drums and sent to storage.

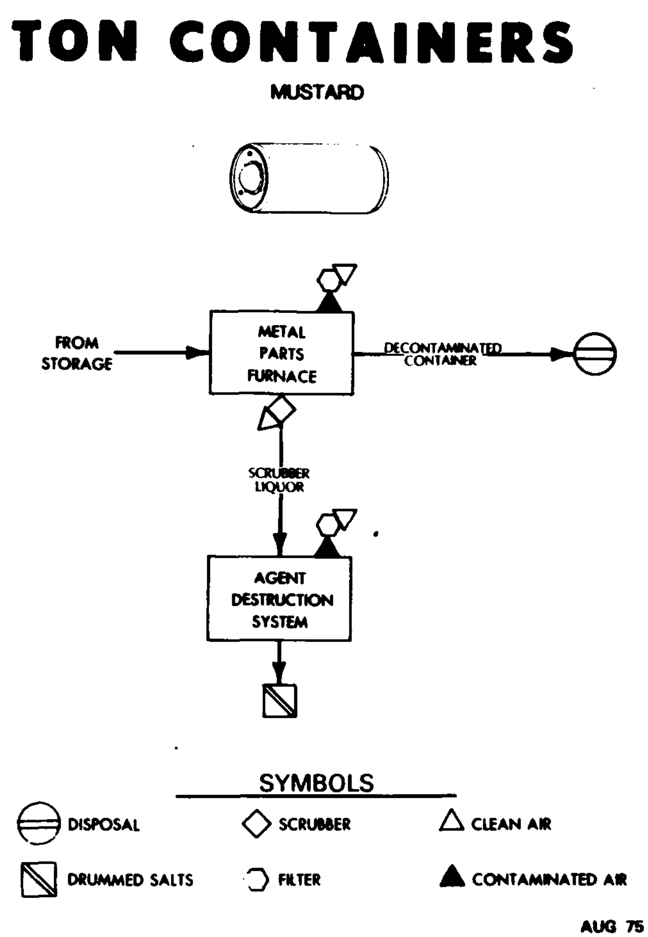


Figure 3-8 Ton Containers, Mustard, Demilitarization Process Flow

SECTION 4

FACILITY/EQUIPMENT DESCRIPTION

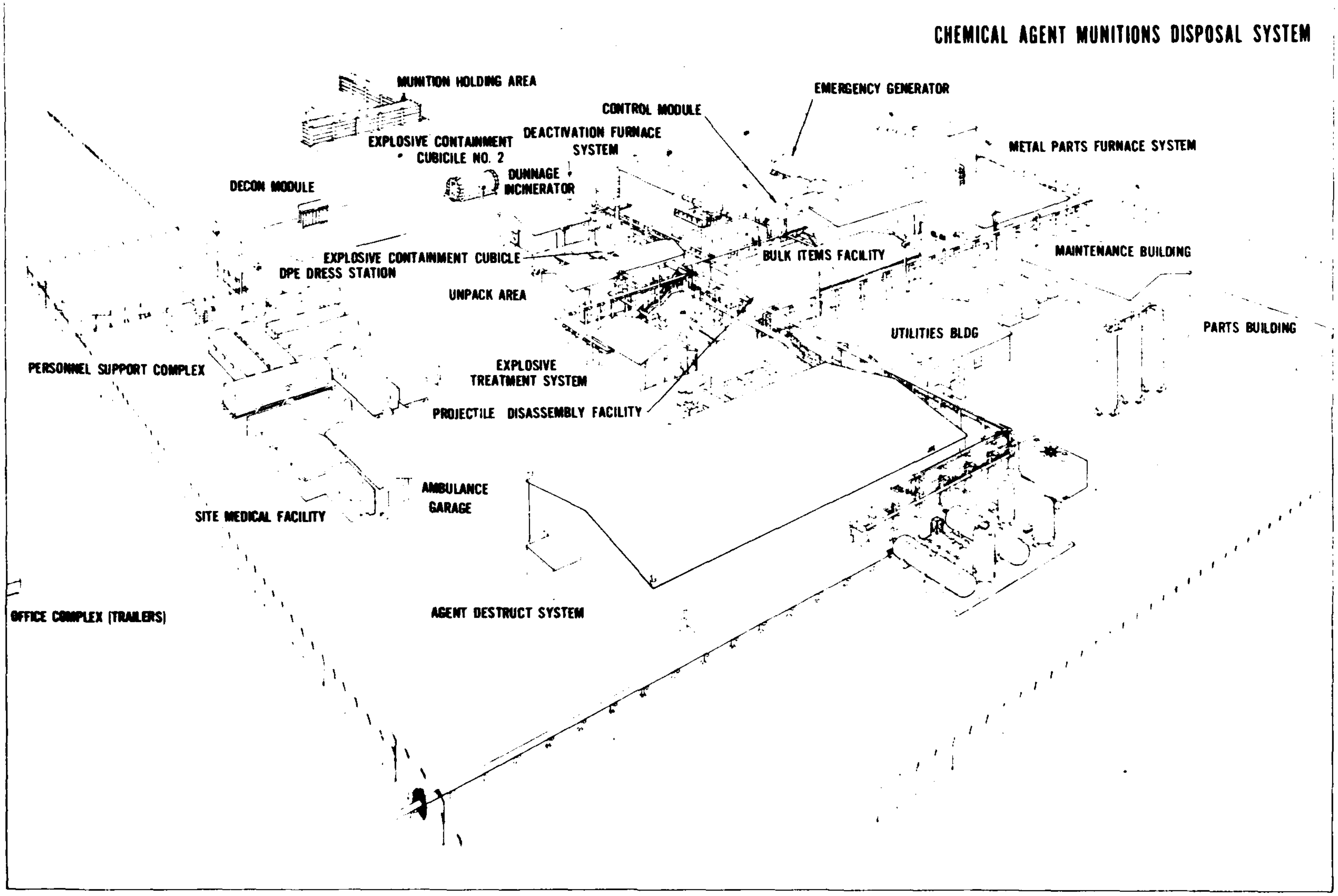
4-1 GENERAL ARRANGEMENT

The overall layout of the CAMDS site is illustrated in Figure 4-1. A double chain link fence with three strands of barbed wire surrounds the perimeter of the site. Access to and from the site is through a guard house in which personnel badges will be exchanged. Personnel entering and leaving the area will pass through the Personnel Support Complex (PSC). The PSC contains a lunch room, lockers, toilet and shower facilities, and clothing storage areas. Vehicle access to the site is also through a double gate sally port. A 20-foot wide bituminous road provides vehicle access around the site inside the fence. A rail line with a tank car unloading station (not shown in Figure 4-1) is located outside the fenced area. Chemicals are pumped from the unloading station to a bulk chemical storage tank area located in the fenced area adjacent to the Agent Destruction System (ADS). Emergency (standby) power is provided for those critical site functions such as filter system blowers, computer and control circuits, essential lighting, etc. All housings are field erected, rigid frame, prefabricated structures. In those areas where agent contamination is possible, the exhaust air is filtered to meet quality standards.

All munitions, with the exception of bulk items, are brought into the fenced area in ammunition transport vans and normally placed in the Munition Holding Area. The munitions are taken from the Munition Holding Area to the Unpack Area (UPA), a totally inclosed ventilated structure in which munitions are manually removed from their pallets or shipping containers. Bulk items are taken directly from the Depot storage area to the Bulk Item Facility (BIF) or Metal Parts Furnace (MPF).

Munitions with explosive components are processed through the Explosive Containment Cubicle (ECC). Projectiles without explosive components are sent directly from the UPA to the Projectile Disassembly Facility (PDF). All combustible non-contaminated dunnage from the UPA is burned in the Dunnage Incinerator (DUN). In the event contaminated dunnage is generated, it will be carried to the MPF for incineration.

The ECC houses the equipment for automated separation of explosive components from the chemical agent and munition hardware. It contains the demil machinery for rocket draining and sawing, mine deburstering and agent removal, mortar deburstering, and projectile deburstering and burster cutting.



CAMDS SITE
FIGURE 4 - 1

The explosive components from the ECC are conveyed to the Deactivation Furnace System (DFS). This furnace is a rotary kiln in which explosive materials and trace amounts of agent are burned. Exhaust gases from the DFS are scrubbed before discharge to the atmosphere. The explosive sludge produced in the ECC is passed through filters located in the ECC housing and then to a decon hold tank also within the ECC housing. From the decon hold tank, it is pumped to the Explosive Treatment System (ETS) for removal of dissolved explosive.

The demil machinery used in the ECC and the PDF is computer controlled. The computer is housed in the Control Center (CON). TV monitors are located in the CON to monitor key process areas.

The MPF is a high temperature, continuous flow furnace for heat treatment of hardware components to insure the destruction of traces of toxic chemicals. The furnace gases are passed through an afterburner and a scrubber system before discharge to the atmosphere. The MPF is also used to incinerate mustard agents directly from munitions and to dispose of contaminated dunnage.

The PDF is a housing which contains the Central Decon System (CDS) and the Projectile Pull and Drain Machine (PPD). The PPD is contained within a separate shroud located in the PDF. The PDF also contains the hydraulic package used for the PPD machine and for the BIF. The PPD is used for draining agent from munitions which do not contain explosives. These munitions come either from the UPA or from the ECC.

The CDS is used to prepare calcium hypochlorite decon solution which is used for agents VX and mustard. It also stores sodium hydroxide. Sodium carbonate decon solution, which is used for agent GB in aluminum munitions, is prepared in the ETS. In the ETS, the filtered explosive sludge solution produced in the ECC is passed through charcoal adsorption columns for removal of dissolved explosives. The ETS filtered solution will be laboratory analyzed for explosive content prior to transfer to the ADS for drying. The standard is less than 0.5 ppm explosive.

The BIF is a separate totally inclosed housing at one end of the PDF which is used to drain agents from GB and VX bombs, spray tanks and ton containers.

The ADS is a chemical plant that detoxifies the nerve agent removed from the munitions. It also treats waste decon solutions generated throughout the CAMDS site. The brine produced from all these operations is dried in the ADS and the resulting salts are drummed. The system is housed in a ventilated structure with filtered exhaust to insure the containment of agent within acceptable emission levels.

The Utilities Housing contains the boilers, air compressors, and 480-volt emergency power for the site. A rail car emergency generator is used for 208-volt emergency power.

All process areas which are expected to become contaminated during normal operation or maintenance will be ventilated at a nominal rate of 25 air changes per hour through banks of high efficiency charcoal filters. Personnel working in these areas will wear level "A" protective clothing of the latest approved design. Process areas, charcoal filter beds and scrubber exhaust stacks will be monitored by toxic agent detectors of the most advanced design. The atmosphere of uncontaminated work areas will be monitored by bubbler stations to provide a measure of trace agent concentrations. An epoxy coating is used on all surfaces throughout the CAMDS facility where there is a potential for contamination. This epoxy coating will provide a surface which is capable of being decontaminated.

Quality control and analytical support to CAMDS operations are provided by a laboratory facility within the Tooele Army Depot South Area but apart from the CAMDS facility.

Medical support for CAMDS operations are provided through an onsite medical facility, staffed 24 hours per day by medical technicians, backed up by a secondary aid station at the South Area administrative area and medical doctors in the Tooele Army Depot North Area.

The DPE dress module is used for dressing in the demilitarization protective ensemble (DPE). It houses the sealing and leak checking equipment used with the DPE.

The decon modules house M3 suits, decon powders, bags, tape, tools and other materials for use by the quick response decon teams in case of an incident.

Equipment maintenance is performed in place or the items are decontaminated and moved to either the toxic maintenance trailer or the maintenance building for repair. Replacement parts are stored in the parts building.

The office trailer complex provides working space of personnel essential to the operation such as the plant operations personnel, metrological surveillance team and monitoring branch personnel.

The primary criteria and critical design parameters for the system and its components are contained in Inclosure 1, Design Criteria.

4-2 MUNITION HOLDING AREA (MHA)

a. Purpose. The purpose of the MHA is to receive munitions into the CAMDS site for unloading, inspection, and preparation for movement to the Unpack Area (UPA).

b. Description. The MHA consists of a L-shaped, 15-foot high, double revetted earthen and steel barricade. Munition vans will be parked behind the barricade. Fifteen feet are required because of the height of the munitions from the ground when loaded on the transport van. An igloo is provided for overnight storage.

c. Operations. Munitions are delivered to the MHA from their storage site in a modified 12-ton munitions van. Security guards and a decontamination truck will escort each load of munitions from the storage area to the CAMDS site. Munitions will be monitored for leakers during in-process holding at the MHA. Individual single pallet only rocket transporter (SPORT) containers, used for all M55 Rockets, will be monitored for leakers prior to movement to the UPA, one at a time, on an as required basis. See Inclosure 17 for complete details on movement of munitions. Surveillance procedures are also contained in Inclosure 17.

d. Safety. The location of the MHA was selected in accordance with AMCR 385-100. Accordingly, the intraline distance between the barricade and nearest inhabited structure is 144 feet which corresponds to an explosive limit of 4,000 pounds within the MHA. The maximum explosive weight anticipated during a normal one-shift operation is 369.6 pounds contained in a load of 105mm M360 Projectiles (See Table 4-1).

Whenever an electrical storm approaches the CAMDS site, personnel will be evacuated from the MHA to the Peronnel Support Complex. If visibility is less than 20 feet, chemical munitions will not be moved from Area 10 to the CAMDS site. Vehicles transporting chemical munitions will be driven at a safe speed which is consistent with weather and road conditions up to a maximum of 20 miles per hour.

Inspection at the storage location will be accomplished by Ammunition Surveillance Division personnel. The pallet of rockets will be visually inspected for liquid leakers prior to placing in the SPORT. SPORTs containing leakers will be tagged with contaminated materiel tags. At the CAMDS site, inspection of munitions will again be accomplished before they are removed from the ammunition van. A vapor leak test of the M55 rocket transport container (SPORT) will be made to detect leakers that may have developed during transportation and handling. Projectiles and boxes will be visually inspected in the MHA to detect external leaks that may have resulted during transportation. Surveillance of serviceable munitions is conducted on a yearly basis and unserviceable munitions on a quarterly basis. Leaking M55 rockets are stored in sealed magazines. These magazines are checked three times a week with an M18 detector kit.

TABLE 4-1

QUANTITY OF EXPLOSIVES AND PROPELLANT TRANSPORTED IN A MUNITIONS VAN

Munition	Agent	Number Per Pallet	Pallets Per Van	Total Agent Weight (lb)	Total Explosive Weight (lb)	Total Propellant Weight (lb)	Total Weight (lb)
Cartridge, 105mm, M360	GB	24	14	537.6	369.6	924.0	14784
Rocket, 115mm, M55	GB	15	3	481.5	144.0	868.5	2565
Rocket, 115mm, M55	VX	15	3	450.0	144.0	868.5	2520
Mine, M23	VX	36	7	3150.0	252.0	None	5796
Cartridge, 4.2 inch, M2/M2A1	HD	40	7	1680.0	196.0	112.0	7000
Cartridge, 4.2 inch, M2/M2A1	HT	40	7	1624.0	196.0	112.0	7000
Projectile, 155mm, M110	H	8	20	1872.0	128.0	None	15840
Projectile, 155mm, M104	HD	8	20	1872.0	128.0	None	15200

Leaking munitions other than M55 rockets found at the MHA will be handled by emergency SOPs using hot line procedures with personnel in level A protective suits. Spills and surface contamination will be decontaminated with appropriate decon solutions. The contaminated munitions will be packaged in plastic bags and taken immediately to the UPA for processing. Containers of decon solution will be maintained within the area for decontamination, should leakage occur.

When processing M55 rockets, each pallet of rockets will be contained in an enclosed SPORT container. This SPORT would contain any liquid agent resulting from a leaking rocket. Each SPORT is monitored in the MHA before it is shipped to the Unpack Area (UPA). If a leaking rocket is indicated, the SPORT is taken to that portion of the UPA which is used to process leaking munitions. If no agent is detected, the rockets are taken to that portion of the UPA where non-leaking munitions are processed.

e. Reference: Inclosure 17, "Surveillance and Movement of Munitions".

4-3 UNPACK AREA (UPA)

a. Purpose. The purpose of the UPA is to provide an area within CAMDS where items to be processed in the Explosive Containment Cubicle (ECC) and/or Projectile Pull and Drain Machine (PPD) can be removed from their shipping and storage containers and prepared for the demilitarization process. The UPA houses an airlock which provides safe entry and exit of the ECC and which contains a personnel shower. A second airlock is also provided which is utilized to introduce into the UPA all leaking munitions and munitions which have not been 100 percent inspected in the storage igloo or at the Munition Holding Area. These munitions include the M23 land mine, the 105mm M360 projectile, and the 4.2 inch mortar. The UPA utilized for processing these munitions also serves as a vestibule for the Explosive Containment Cubicle (ECC).

b. Description. The UPA consists of three areas: the unpack operating area for processing non-leaking munitions, the unpack operating area for processing leaking munitions and munitions which have not been 100 percent inspected, and the airlock areas. The UPA is physically connected to the ECC housing and faces the Personnel Support Complex (PSC). Figure 4-2 depicts the UPA.

(1) Unpack operating area for processing non-leaking munitions. The unpack operating area consists of two scrap hoppers, work table, floor-mounted pneumatically operated jib crane, material handling equipment, an emergency shower, and ample working room for at least three operators to work in a safe manner. Two personnel doors equipped with non-shatterable plastic windows and panic devices are provided as is a munition access door which is large enough to accommodate a fork lift truck. A ventilation system, exhausted through charcoal filters, provides six air changes per hour in this area. The ventilation air flow is from the non-contaminated zone in the UPA, through the contaminated airlock area and ultimately through the filter elements.

(2) Airlock area. Included in the airlock area are a fresh water shower, a decon area, an undress area, tool storage area, and one foot bath located at the ECC personnel door. When leaving the airlock the operators will scrub their protective clothing with decon solution. The protective suit is rinsed to remove decon solutions in the fresh water shower cubicle. Agent detectors (M8) are provided so personnel in the unpacking area can demonstrate that workers leaving the shower are not contaminated. The operators within the shower cubicle monitor themselves for contamination with the detector probe after showering, and then remove their boots and gloves. They then proceed to the undress area to remove their protective clothing. An observation window is provided so personnel in the unpack operating area can observe the entire airlock area. The ventilation system provides a negative pressure between the contaminated zone and the Unpack Area, with 25 air changes per hour through the airlock.

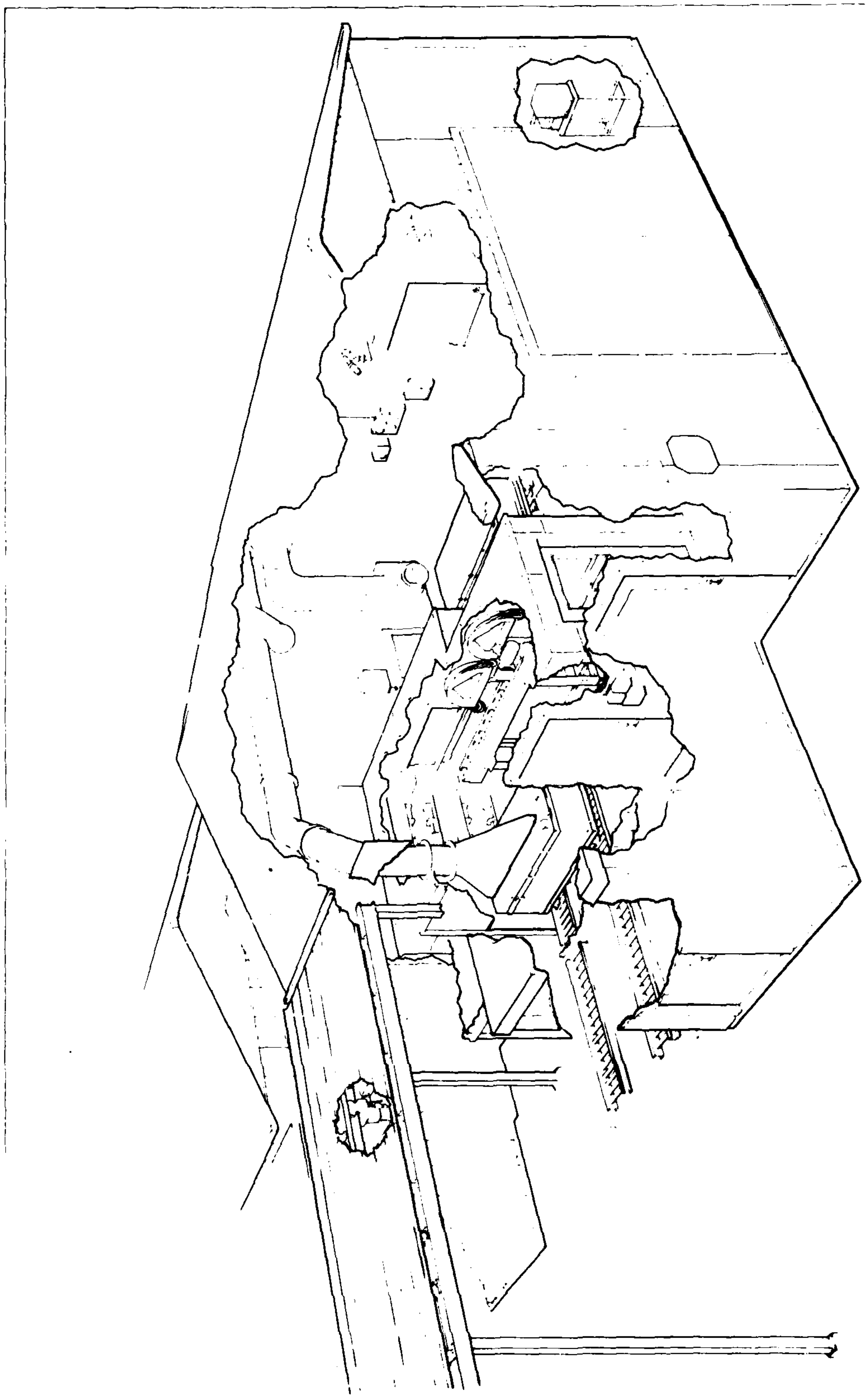


FIGURE 4-2 UNPACK AREA

(3) Unpack operating area for processing leaking munitions and munitions which have not been 100 percent inspected. This area consists of an unload area with an overhead roof. The unload area contains a conveyor for transporting munitions through a double door airlock area into the ECC vestibule area for downloading. Operators in this ECC vestibule area, operators will follow the same decon procedures outlined in paragraph (2).

Air exhaust passes through a charcoal filter system. A revolving munitions loading door seals the UPA from the toxic ECC vestibule to preclude back flow of contaminated air to the clean UPA. The door is used for feeding items onto the ECC input conveyor.

Floor drains in the unpack operating area, in the shower cubicle and in the toxic cubicle will carry waste from the shower and from area wash-down to a sump located in the ECC housing area. The waste will be pumped on demand, automatically, to a waste neutralization tank in the Agent Destruction System (ADS) for certification by the addition of five percent excess sodium hydroxide/carbonate prior to drying in the ADS drum dryers. To preclude back flow of contaminated air into the uncontaminated Unpack Area, the floor drains will contain water traps. In addition, the drain entrance in the clean area will be mechanically plugged and sealed with lead seals until it is required for draining. Removal and reinsertion of the plug and seal will be noted in the operating log and will be routinely inspected by QC as being in place.

c. Operation. Munitions processed through the ECC and PPD come to the UPA by way of the Munition Holding Area from their various storage sites.

All munitions, except bombs, spray tanks and ton containers, will be received, inspected, and unpacked in the UPA. They will have been inspected for leakage externally at the storage site and again at the MHA. Transfer from the MHA to the UPA is accomplished with a transporter vehicle. The transporter operator, upon request from the UPA operator, enters the UPA with a palletized load of munitions. He places the pallet near the ECC input conveyor. The transporter operator then proceeds to carry out other assigned duties which include removing dunnage which is too large for the hoppers, and transferring full hoppers of dunnage to the Dunnage Incinerator (DUN). The UPA operators will not begin to process the munitions until the transporter operator has completed his duties, the transporter has been removed, and the munition access door has been closed.

The UPA has seven different configurations which are designed to handle the different munition types.

(1) UPA Configuration No. 1. M55 rockets are delivered to the UPA in an enclosed Single Pallet Only Rocket Transporter (SPORT) that can handled these munitions in their storage configuration (see Inclosure 17, Annex N for photograph of rockets in storage). Each SPORT container is monitored for leaking rockets in the MHA. If no leakers are detected, the SPORT is delivered to the UPA and monitored with M8/Concentrator prior to downloading. The rockets are then removed from the pallet and inserted one at a time through a revolving munitions loading door in the toxic shroud onto the ECC rocket input conveyor to be processed through the Rocket Demil Machine (RDM) in the ECC. The dunnage generated from each pallet of rockets consists of spacers, banding, end panels. saddles and the pallet itself.

If the SPORT container is monitored and found to contain leaking rockets, it is delivered to that portion of the UPA that processes leaking munitions. The SPORT container is placed on a conveyor and then it is transported through a double door airlock into the ECC vestibule area. The cover is removed from the SPORT and localized ventilation is utilized to exhaust any toxic vapors. Personnel working in this area will wear level A protective clothing. The rockets are removed one at a time, deconned as required and placed on the ECC rocket input conveyor to be processed in the RDM. After removing the last rocket from the SPORT, all remaining dunnage from the pallet is placed in the SPORT, the cover installed, and the exterior of the SPORT decontaminated. The SPORT exterior is checked for contamination and then delivered to the Bulk Item Facility (BIF). In a ventilated area of the BIF, the dunnage will be flushed with decon. The surface decontaminated (3X decontaminated) dunnage will be stored at the BIF or moved to a controlled access area for future processing through the MPF. Dunnage will eventually be loaded in a dunnage processing fixture for processing through the MPF. Production control personnel will control the storage location and accountability through destruction of the dunnage. The empty SPORT will be internally and externally deconned and inspected by QC for contamination. Clean SPORTS will be returned to service.

(2) UPA Configuration No. 2. M23 mines are packaged three mines to a steel drum. The drums have been depalletized to facilitate storage (see Inclosure 17, Annex P for photograph of mines in storage). The mine drums will be repalletized, 12 drums (36 mines) on a wooden pallet and brought to the portion of the UPA which processes munitions which have not been 100 percent inspected. The UPA operator dismantles the pallet and removes a steel mine drum containing three mines and places it on the floor. He then cuts the seal wire and bolt that holds the lid clamp together. Although the mine drum has been previously inspected, the first opportunity for "leaker" detection of the mine itself is after the lid is removed from the sealed drum. Because of the remote possibility of finding a leaker, operators must wear level B clothing while removing mines from the drums.

The UPA operator removes the clamp to allow access to the mines and then looks for indications of leakage such as the presence of a liquid, peeling paint or discoloration of the mine body. A suspect liquid will be checked with M8 detection paper. The mines, activators and fuzes are separated from each other within the steel drum. The fuzes and activators are removed and packaged to be returned to storage along with the mine drums every 4 hours. No components from contaminated drums will be returned to storage. If the drum contains a leaking mine, the fuzes and activators will be rinsed in decon solution, placed in an air tight drum, and held in the airlock, pending disposal in the Deactivation Furnace. The drums and packing will be bagged and held for disposal in the Metal Parts Furnace.

Once the fuzes and activators have been removed from the drum, the UPA operator proceeds to remove the mines, one at a time, from the drum. The mines are packaged upside down with the mine handle up. The operator reaches into the drum, grasps the mine handle and slowly removes the mine being careful to inspect the mine for leakage as evidenced by the presence of liquid, peeling paint, or discoloration of the mine body. If leakage is discovered, the mine and the containers will be immediately decontaminated and operations will continue. If a gross leakage is apparent and there is indication the mine cannot be processed further without spreading contamination, it will be repackaged in a suitable overpack and returned to storage. The decision to process or return to storage will be made by the shift supervisor.

If the mine is determined to be a non-leaker, it is placed on the work table and the operator, using an approved tool, removes the arming plug and spring. The arming plug and spring are placed in a special 2' x 2' hopper. The mine is then placed on the ECC mine input conveyor. The operator will position the handle so that it will actuate the microswitch on the ECC mine input conveyor that signals the computer to begin the demil process. The other mines are then prepared to be demilled. Since the mine drum, fuzes and actuators are returned to storage, the dunnage and/or scrap generated from a pallet of mines is limited to the packaging material. Because the mines are not stored on pallets, the pallets will be used again to transfer more mines from their storage site.

(3) UPA Configuration No. 3. 105mm M360 burstered projectiles are brought to the UPA in their storage configuration (see Inclosure 17, Annex J for photograph of projectiles in storage). These munitions are processed through that portion of the UPA which handles munitions which have not been 100 percent inspected. Because of the remote possibility of finding a leaker, the operators must wear level B clothing. The UPA operators begin to prepare the projectiles for demil by cutting the banding and placing it in a hopper. They then lift one of the boxes (containing two projectiles) and place it upon the work table where the box banding and seal are cut and placed in a hopper.

The operators then open the box, insert a toxic agent detector probe to determine the presence of leakers, and remove the entire contents (fiber containers with ammunition and packaging material). The projectile is contained within a fiber container. The operator unwraps the tape on the fiber container and removes the container lid, allowing access to the projectile. The projectile is removed and placed upon the ECC input conveyor. When the operators have processed both projectiles (2 each box), they place the lid on the box, the box is inspected to insure it is non-contaminated, and the contents and box are returned to storage. The salvable material consists of cartridge case, propellant, fiber container, wooden box, and packing stop. The scrap generated from a pallet of burstered 105mm projectile consists of the steel banding. In the unlikely event leakage is detected, the entire contents of the box will be chemically deconned and sealed in a plastic bag and metal drum for later disposal. The projectile will be externally deconned, and then processed through the ECC.

(4) UPA Configuration No. 4. 105mm M360 non-burstered projectiles are brought to the UPA in their storage configuration (see Inclosure 17, Annex A for photograph). The UPA operators begin to prepare the projectiles for demil by cutting the pallet banding and placing it in a hopper. Projectiles are removed from the pallet and placed on the ECC by-pass conveyor and transferred to the Projectile Disassembly Facility (PDF) to be processed in the Projectile Pull Drain Machine (PPD). The dunnage and/or scrap generated from a pallet of 105mm non-burstered projectiles consists of steel banding and the pallets. Inspection for leakage and handling of leakers will be accomplished as in paragraph (3) above.

(5) UPA Configuration No. 5. 155mm M110 and M104 burstered projectiles are stored as loose rounds (see Inclosure 17, Annexes L-M for photographs). Therefore, they must be transferred from their storage site, using a specially designed carrying tray. The 155mm projectile size prohibits manual lifting. The UPA operator hooks the jib crane from the carrying tray. With the projectile suspended, the operator cuts the wires that hold the grommet (rotating band projector), removes the grommet and places it in a hopper. The projectile is lowered onto a specially designed tilt table which will help to take the projectile from a vertical to a horizontal position. The projectile is then rolled onto the ECC input conveyor where it will be introduced into the ECC for demil. Scrap generated from a transported load of projectiles will be limited to the steel grommets. The carrying tray will be returned to storage. Leakage of agent will not be a problem since the projectile can be thoroughly inspected at the MHA before movement to the UPA.

(6) UPA Configuration No. 6. 155mm (M121, M121A1, M122) and 8 inch M426 projectiles without explosives are brought to the UPA in their storage configuration (see Inclosure 17, Annexes B-F for photographs). The UPA operators begin to prepare the projectiles for demil by cutting the pallet banding (either 155mm or 8 inch) and placing it in a hopper. Projectiles are removed from the pallet, using the jib

crane; the steel grommet is removed, and the projectile is lowered onto a tilt machine which positions it in the horizontal position. The projectile is then rolled onto the ECC by-pass conveyor and transferred to the Projectile Disassembly Facility (PDF) for demil in the Projectile Pull and Drain Machine (PPD). The dunnage and/or scrap generated from a pallet of projectiles consists of steel banding, steel grommets and pallets (155mm or 8 inch).

(7) UPA Configuration No. 7. 4.2 inch mortar cartridges are brought to that portion of the UPA which processes munitions which have not been 100 percent inspected. Their storage configuration is illustrated in Inclosure 17, Annex K. Because of the remote possibility of finding a leaker, the operator must wear level B protective clothing. The UPA operator begins to prepare the mortar for demil by cutting the banding and placing it in a hopper. The container will be inspected for leakage when the box is opened and when the round is removed from the fiber container. The 4.2 inch mortar cartridge and packing material are then removed and placed on the work table (see Figure 4-3). The round is taken out of the fiber container and placed in a pipe vise. To remove the striker nut assembly, the operator grasps the nut with his hand and turns it counterclockwise (striker nut should have been assembled hand tight). If the striker nut should be too tight to remove by hand, a pneumatically operated wrench will be used. The operators will be protected by an anchored flash shield in front of the vise fixture. While the round is still in the vise, the operator removes the ignition cartridge, the spring clip that is holding the propellant wafers in position, and removes the wafers. A wrench is then used to remove the obturator and base plate. The base plate is removed to facilitate clamping of the round in the PPD. The striker nut assembly, ignition cartridge, propellant, obturator and base plate assembly are packaged and transferred to storage. The mortar is then placed on the ECC input conveyor. Dunnage and/or scrap generated by a pallet of 4.2 inch mortar cartridges consists of steel banding, fiber containers and wooden storage boxes. Leakers will be rinsed with decon solution and then processed in the normal manner. No components of contaminated rounds will be returned to storage. They will be chemically deconned and placed in suitable containers for subsequent disposal in the Deactivation Furnace. Contaminated containers will be chemically deconned and packaged for final disposal in the Metal Parts Furnace.

d. Safety. Each configuration of UPA operation has been developed to provide the operators with maximum safety. Although the munitions are expected to be "clean" when they enter the UPA, contingency procedures have been developed to handle leakers should any trace of contamination be found while processing the munitions. These procedures include shutdown of the operation and evacuation of operation personnel if necessary. Munitions which cannot be inspected for leakage in the Munition Holding Area will be unpacked by operators in level B clothing in the ECC vestibule area. If liquid leakers are encountered, personnel wearing level A protective clothing will enter the UPA, process the leaking munition, and decon the contaminated area. The time to accomplish these tasks will be determined during system tests. The UPA ventilation system and the use of the ECC vestibule area for unpacking

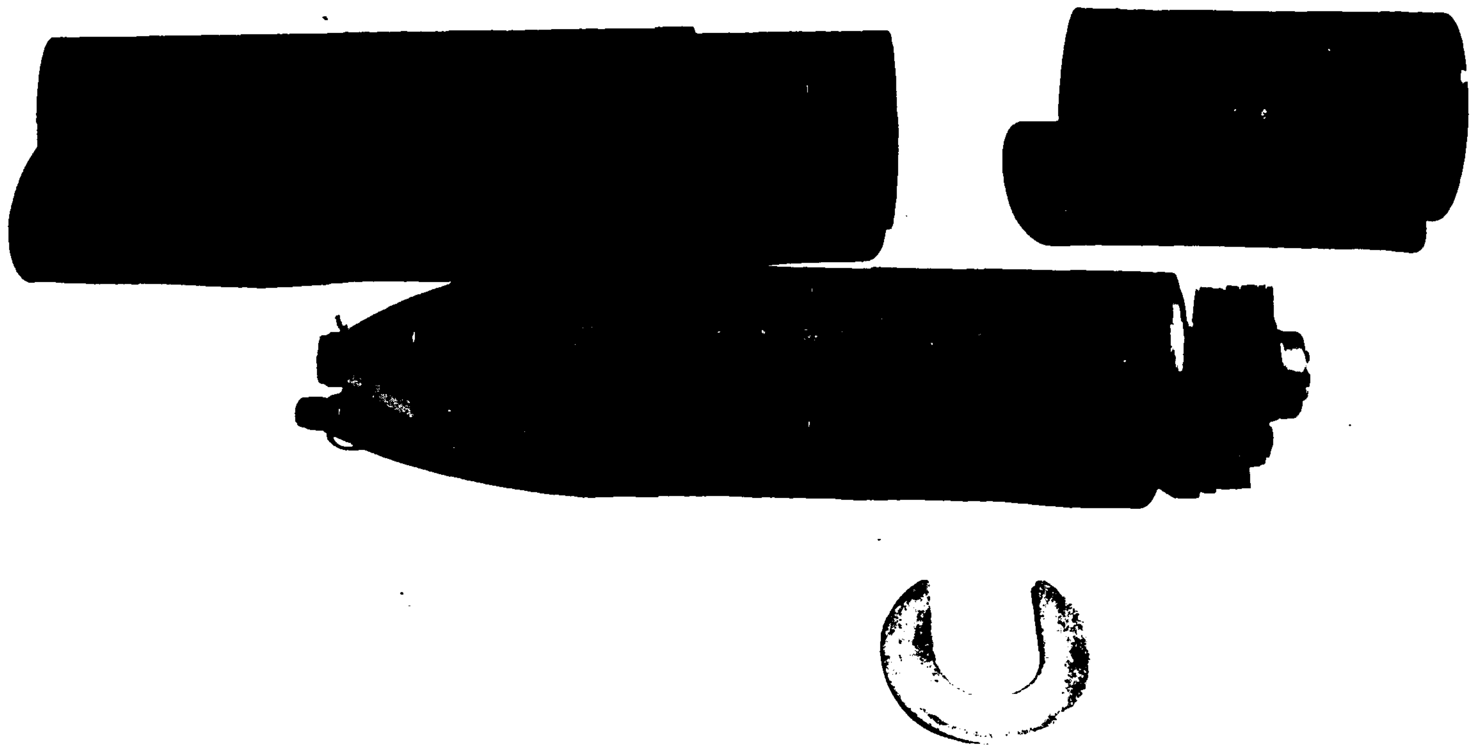


Figure 4-3 4.2 Inch Mortar Assembly

potential leakers will prevent release of agent to clean areas during this operation. In the unlikely event a liquid leaker is so large that further processing would spread contamination, the munition will be placed in plastic bags and sealed metal drums and returned to storage pending disposal by approved SOPs. The shift supervisor will make this decision. Contaminated dunnage will be disposed of in the Metal Parts Furnace.

Because some of the items to be processed in the UPA are explosively loaded, the UPA has been designated according to quantity-distance considerations. A maximum of 50 pounds of mass detonatable explosive can be held within the UPA at one time. All munitions will be brought to the UPA in amounts that will allow the least amount of explosive in the UPA and still provide efficient operation. A maximum of two pallets of M55 rockets (two SPORTS) are permitted in the UPA at one time as long as one SPORT remains closed. This will permit one SPORT to be monitored while a second pallet is being processed. Although one pallet of M55 rockets contains 48 pounds of high explosive, tests have shown that detonation of one rocket in a pallet will not propogate to any other rockets in the same pallet. Since rockets will not propogate within a pallet, resulting in a mass detonation of the total 48 pounds explosive per pallet, there would be no propogation to a second pallet of rockets in the unpack area. Based on the above, the total quantity of explosives in the UPA that will mass detonate is well under 50 pounds. This excludes the rocket propellant weight based on tests conducted at Tooele Army Depot (Test Report CAMDS 6-2, "M55 Rocket Propellant Test" Inclosure 11), which indicate the propellant does not contribute to the explosive capability of the munition.

The UPA is a monitored area which is always in contact with the control module. The UPA is monitored with an M8/Concentrator and bubbler which have the following sensitivities to agent GB.

	Sensitivity (mg/m^3)	Response Time
M8/Concentrator	.2	1 minute
	.001	33 minutes
Bubbler	.0001	2 hours
	.000003	13 hours

If an operator suspects he is exposed to agent contamination, he will mask as quickly as possible, decontaminate himself with suitable decon solution and shower with his protective clothing on.

The floor surface is covered with a special laboratory tested epoxy surface and sloped toward the drain. All electrical fixtures exposed to the process area are NEC Class 11, Group EFG. Fire extinguishers are provided as described in SB-11, TB5-4200-10 and AR 420-90.

Dunnage will be burned in the Dunnage Incinerator. Salvageable materials will be certifed thermally treated to 5X before they can leave the CAMDS site.

All operations in the main area of UPA will be in level E clothing. When handling mines, boxed 105mm projectiles and 4.2 inch mortars, level B clothing will be used. If an operator in level E clothing suspects he is exposed to agent contamination, he and his co-worker will mask as quickly as possible, alert the control room and activate a set of red revolving lights located at the entrance of the UPA. These lights warn other site personnel not to enter the area. The operators will then move to the ECC vestibule shower, shower, verify decontamination with an M8 and move to the Medical Module for evaluation. In the event an operator in the Demilitarization Protective Ensemble (DPE) is injured, his buddy will assist him to the airlock shower area, wash his boots, gloves and other areas of his suit with decon, and give him a shower. In the event the injured individual is unconscious, a standby operator in protective clothing will come into the area and assist the buddy in carrying the injured operator to the airlock to be showered. After he is monitored with an M8, his buddy will cut him out of the DPE. The injured operator and his assistants will keep their respirators on and the injured operator will then be taken to the site medical module for treatment.

Features applicable to overall safety are given in Section 8.

e. References. Inclosure 17, "Surveillance and Movement of Munitions".

4-4 EXPLOSIVE CONTAINMENT CUBICLE (ECC)

a. Purpose. The ECC's primary purpose is to retain the fragments and chemical agents that would result from an explosive incident (a very remote possibility) during demilitarization of chemical munitions. All munitions that contain explosive components will be processed through the ECC to separate the explosives from the chemical agent and, if necessary, to cut the explosives into sizes small enough to process through the Deactivation Furnace. The chemical agents will be drained from rockets and mines in the ECC.

b. Description. Figure 4-4 is an artist's concept of the ECC. It is a steel cylinder with an inside diameter of 10 feet, 24½ feet long, fabricated from 2½ inch thick steel plate. Welded to each end of the cylinder is a steel flange 2½ inches thick by 14 inches wide. The flanges are used to bolt 2½ inch thick reinforced end panels to the cylinder.

The entrance end panel contains an inward-opening hinged personnel door for passage of maintenance personnel. A smaller door within the personnel door and three small doors in the discharge end panel allow passage of munitions and ventilation air. The doors are remotely operated using hydraulic actuators and locking pins. A manually operated unlock mechanism will allow the ECC personnel door to be opened by operators outside the ECC in the event of hydraulic system failure. The doors contain specially designed seals to prevent agent leakage during normal operations and to prevent massive leakage in case of an explosive incident. Electrical, hydraulic and pneumatic services enter the ECC through specially designed connectors located in the end panels. Chemical agent is discharged through a barricaded pipe in the center of the cylinder. The ECC is treated as a contaminated area requiring personnel to wear level A protective clothing at all times. Entrance to the ECC is through the airlock in the Unpack Area housing.

The ECC is located inside a heated and ventilated housing as shown in Figure 4-4. The ECC housing has a common wall with the Unpack Area at one end and joins the Deactivation Furnace barricade at the other end. The housing also contains shrouded and ventilated ECC discharge conveyors, the Deactivation Furnace input conveyor, bag-type sludge filters, a decon solution hold tank and an airlock.

A large concrete pit under the ECC within the housing contains a standby agent transfer pump and a waste water sump tank which receives shower wastes from the Personnel Support Complex, the Unpack Area and the ECC housing airlock. The contents of the sump are periodically pumped to the Agent Destruction System waste neutralization tank for necessary treatment and certification of 5 percent sodium hydroxide/carbonate prior to drying. The pit also provides access to hydraulic piping between the ECC and the hydraulic module. A second sump in the main floor of the

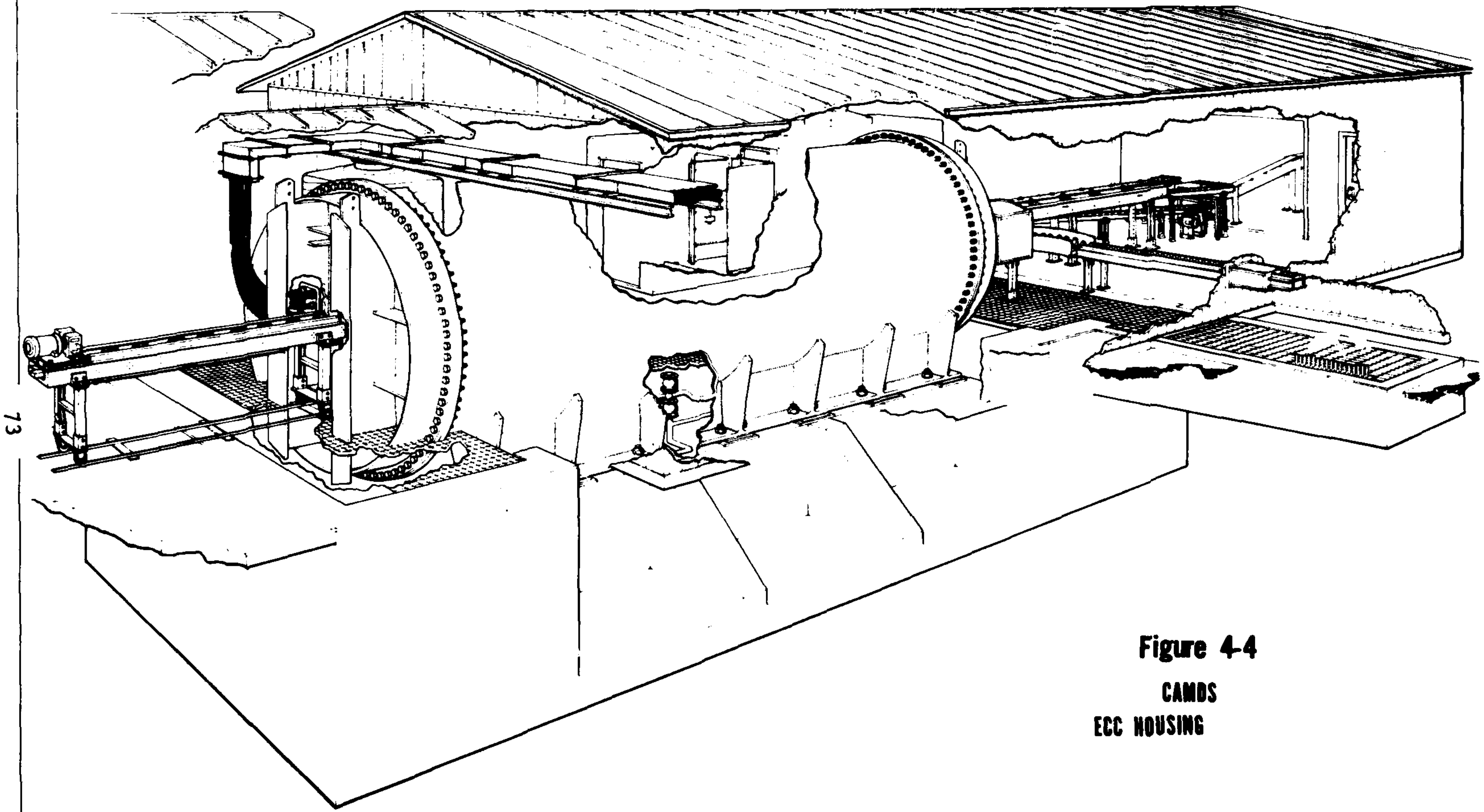


Figure 4-4
CAMDS
ECC HOUSING

JULY 1975

ECC housing receives floor and discharge conveyor washings. These solutions may contain explosive particles; therefore, this sump is pumped periodically through the bag filters to the decon solution hold tank and ultimately through the ETS charcoal filter columns to the Agent Destruction System waste neutralization tank.

A ventilation system maintains the ECC and the ECC housing under negative pressure in relation to atmospheric pressure. Ventilation air is pulled through activated charcoal filters to remove traces of chemical agent vapors. The housing is treated as a level "A" contaminated area. Entrance to the housing is through an airlock which contains a fresh water shower and an undress area comparable to the Unpack Area airlock. Personnel decon procedures employed in the ECC housing are the same as those in the UPA airlock. Personnel leaving the airlock will be transported to the Personnel Support Complex (PSC) using a transporter vehicle. This vehicle will back up to the airlock undress area door. An overhead covering is provided in this area which provides protection to personnel entering the van.

Four separate machines are designed for installation in the ECC, one at a time, dependent on the type of munition to be demilitarized. They are the Rocket Demil Machine (RDM), the Projectile Demil Machine (PDM), the Mortar Demil Machine (MOR) and the Mine Demil Machine (MIN). The ECC input conveyor for each machine is installed inside of an airlock in the Unpack Area.

c. Operation. The operation of the ECC doors and all equipment in the ECC is computer monitored and controlled. The logic and sequence of operation is explained in detail in subsequent paragraphs describing the operation of the equipment in the ECC. The processing solution from the Rocket Demil Machine is pumped through bag filters located in the ECC housing and into a decon hold tank also located in this housing. The solution is pumped in small quantities periodically during each shift of operation and fresh decon is added to the saw tank to make up the lost volume. Once every shift, the decon hold tank solution is checked for pH and then pumped to the Explosive Treatment System for further processing.

d. Safety. The ECC was designed to withstand the explosive force of the worst case munition (8-inch projectile). The criteria for design was total fragment containment and minimal agent leakage in case of an explosive incident. Based on dynamic certification and pneumatic tests conducted on the ECC, leakage from the ECC after an explosive incident will not exceed 0.1 CFM.

Any agent emission from the ECC, in case of an incident, will leak into the ECC housing and will then be absorbed in the charcoal filter of the ECC housing ventilation system which has a capacity of 6000 CFM.

All equipment operations are remotely controlled and monitored by computer. The computer is programmed so a series of "GO-NOGO" situations are encountered during process operations. If the proper conditions are not met, the operation is discontinued and a readout in the Control Center indicates which condition has not been fulfilled. The operation will not resume until the "NOGO" situation causing the shutdown has been corrected or overridden by the direction of the shift supervisor. The adequacy of the computer logic for all operations, including interlocks, and the adequacy of all control sensors and overrides will be validated during pre-operational testing of CAMDS.

All penetrations through the ECC wall for hydraulic, electrical, decon solution, agent and drain lines have been designed to prevent leakage of contaminated air during normal operations and to minimize leakage in case of an explosive incident. Leakage from the ECC into the ECC housing after an explosive incident will not exceed 0.1 CFM.

A foot bath will be provided by the ECC personnel door so that contamination from the ECC to the airlock area is minimized. A foot bath will also be provided at the entrance to the ECC housing airlock.

Although the ECC and the ECC housing are designated contaminated areas requiring level A protective clothing for all operating and maintenance personnel, extensive efforts have been made to reduce the level of agent contamination. Where possible, equipment used in these areas has been provided with local ventilation and has been designed to prevent or to catch and decontaminate liquid agent drippings. Water-glycol hydraulic systems will be used and hydrocarbon lubricants will be minimized. Prior to operations, extensive tests of the ventilation system will assure proper air flow and differential pressure and will establish the agent vapor purge capability of the ECC.

e. References. Summary of tests in references 2 through 18 are contained in Inclosure 5.

(1) "Fragment Penetration Calculations", 28 Nov 1973, by Ammon and Whitney Consulting Engineers, New York, N.Y. A theoretical calculation of fragment penetration into the ECC walls in case of an explosion.

(2) "Analyzation of Seals", 16 Oct 1970, by Utah Research and Development Co., Inc., Salt Lake City, Utah. A study to determine the best material to use for the ECC door seals.

(3) Test Report CAMDS 2-1. "Fragmentation Test of 8 inch Projectile", 13 Aug 1970, by Ammunition Equipment Office (AEO), Tooele Army Depot (TEAD), Test to determine size and velocity of primary and secondary fragments resulting from a detonation. Data used as design parameters for the ECC.

(4) Test Report CAMDS 2-2. "Fragmentation Test of 115mm Chemical Rocket", 25 Aug 1970, by AEO-TEAD. Test to determine size and velocity of primary fragments resulting from detonation. Data used as design parameters for the ECC.

(5) Test Report CAMDS 2-3. "ECC Penetration Tests", Aug - Oct 1973, by AEO-TEAD and Los Alamos Scientific Laboratory, Los Alamos, New Mexico. Tests to determine the type of fittings to use for penetration through the ECC walls.

(6) Test Report CAMDS 2-4. "Flange Bolt Gasket Test", by AEO-TEAD. Test to assure ECC end panel bolt gaskets would not leak.

(7) Test Report CAMDS 2-5. "Dynamic Tear Tests", 1 Aug 1973, by Southwest Research Institute, San Antonio, Texas. Tests to assure there were no defects in the steel used to fabricate the ECC.

(8) Test Report CAMDS 2-6. "Door Seal Test", Jan 1972, by AEO-TEAD. Test to check design integrity of ECC door seal using scale mock-up.

(9) Test Report CAMDS 2-7. "Ultrasonic Inspection of Steel Plate", March 1972 by Pittsburg Test Laboratory. Test to check the quality of steel and welds used in fabrication of the ECC.

(10) Test Report CAMDS 2-8. "Microscopic Inspection of Welds", Apr 1972, by IIT Research Institute, Chicago, Ill. Tests to check quality of welds used in fabrication of the ECC.

(11) Test Report CAMDS 2-9. "ECC Fragmentation Test", Aug 1972, by AEO-TEAD. Munitions were detonated in an 8-foot test section of an ECC to check fragment retention.

(12) Test Plan CAMDS 2-10. "Pilot Test on Door Seals". A test planned by AEO-TEAD to check the door seals and door operating mechanism using full size mock-up.

(13) Test Plan CAMDS 2-11. "Hydrostatic Test No. 1". A planned test on the first ECC at the factory.

(14) Test Plan CAMDS 2-12. "Hydrostatic Test No. 2". A planned test on the first ECC after shipment to TEAD.

(15) Test Plan CAMDS 2-13. "Ultrasonic Inspection of Welds". A planned test to check ECC welds after Hydrostatic Tests.

(16) Test Plan CAMDS 2-14. "Air Lock and Ventilation Tests". A planned test to check door seals in actual operating environment.

AD-A078 844 ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY ABERDEEN P--ETC F/G 15/2
OPERATION OF THE CHEMICAL AGENT MUNITIONS DISPOSAL SYSTEM (CAMD--ETC(U)
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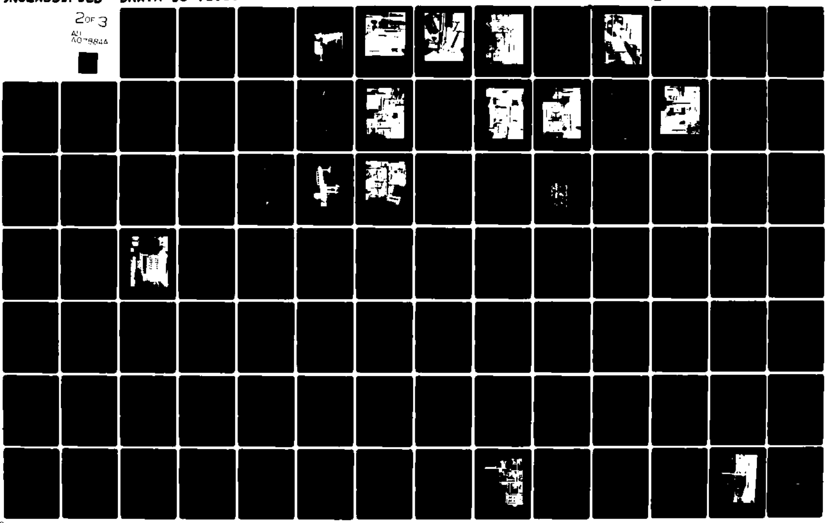

(17) Test Plan CAMDS 2-15. "Final Gas Leak". A planned test to pressurize the ECC and check for gas (Freon) leaks.

(18) Test Plan CAMDS 2-16. "Dynamic Test on ECC No. 2". A planned test to check the design integrity of the ECC by detonating an explosive charge inside an ECC.

4-5 ROCKET DEMIL MACHINE (RDM)

a. Purpose. Figure 4-5 is an artist's concept of the RDM installed in the Explosive Containment Cubicle (ECC). The RDM is used to drain the agent from the rocket warhead and to cut the rocket into sections small enough to process through a deactivation furnace.

During initial design stages, the RDM was referred to as the Punch, Drain and Saw Machine (PDS). This terminology was used in various test reports written at that time. Those reports will be used as part of this document. RDM and PDS are synonymous where used in this text.

b. Description. The RDM is a multistation machine consisting of the following conveyors and stations.

(1) ECC input conveyor (Figure 4-6). This conveyor, located in the airlock of the Unpack Area is an electric motor powered roller conveyor with a moveable bed actuated by a hydraulic cylinder. The moveable bed is used to move the rocket from the Unpack Area into the ECC. The powered rollers are used to move the rocket off from the ECC input conveyor onto the RDM input conveyor.

(2) RDM input conveyor (Figure 4-7). This conveyor, located in the ECC is an electric motor powered roller conveyor with a pivoting hydraulic push cylinder mounted on the conveyor frame. The powered rollers are used to move the rocket into the punch and drain station. The push cylinder is used to move the rocket into the saw station.

(3) Punch and drain station (Figure 4-8). The punch and drain station consists of a hydraulic clamp and two hydraulic punches. The bottom clamp jaw is stationary and has an agent drain hole drilled through it. An agent catch tank is connected by pipe to the bottom clamp. The top clamp jaw moves vertically. The two punches are attached to and move with the top clamp jaw. The top jaw is drilled so the punch rods operate through the top jaw. Seals are installed around the punch rods in the top clamp jaws. A catch pan, irrigated with decon solution, is attached to this station and extends to the saw tank to assure containment of agent drippings.

(4) Saw station (Figure 4-9). The saw station has four idler rollers, raised and lowered by hydraulic cylinders, that support the rocket as it moves into the RDM. It has seven sets of horizontal operating hydraulic cylinders that are in line with the rocket when the rocket is on the idler rollers in their raised position. Impaling punches are mounted on the second set of clamps from the punch station. Another pair of impaling punches are located adjacent to the fourth set of clamps from the punch station. It has six motor driven radial saws that are raised and lowered by hydraulic cylinders. All of the above components are mounted on a vertical moveable hydraulic powered

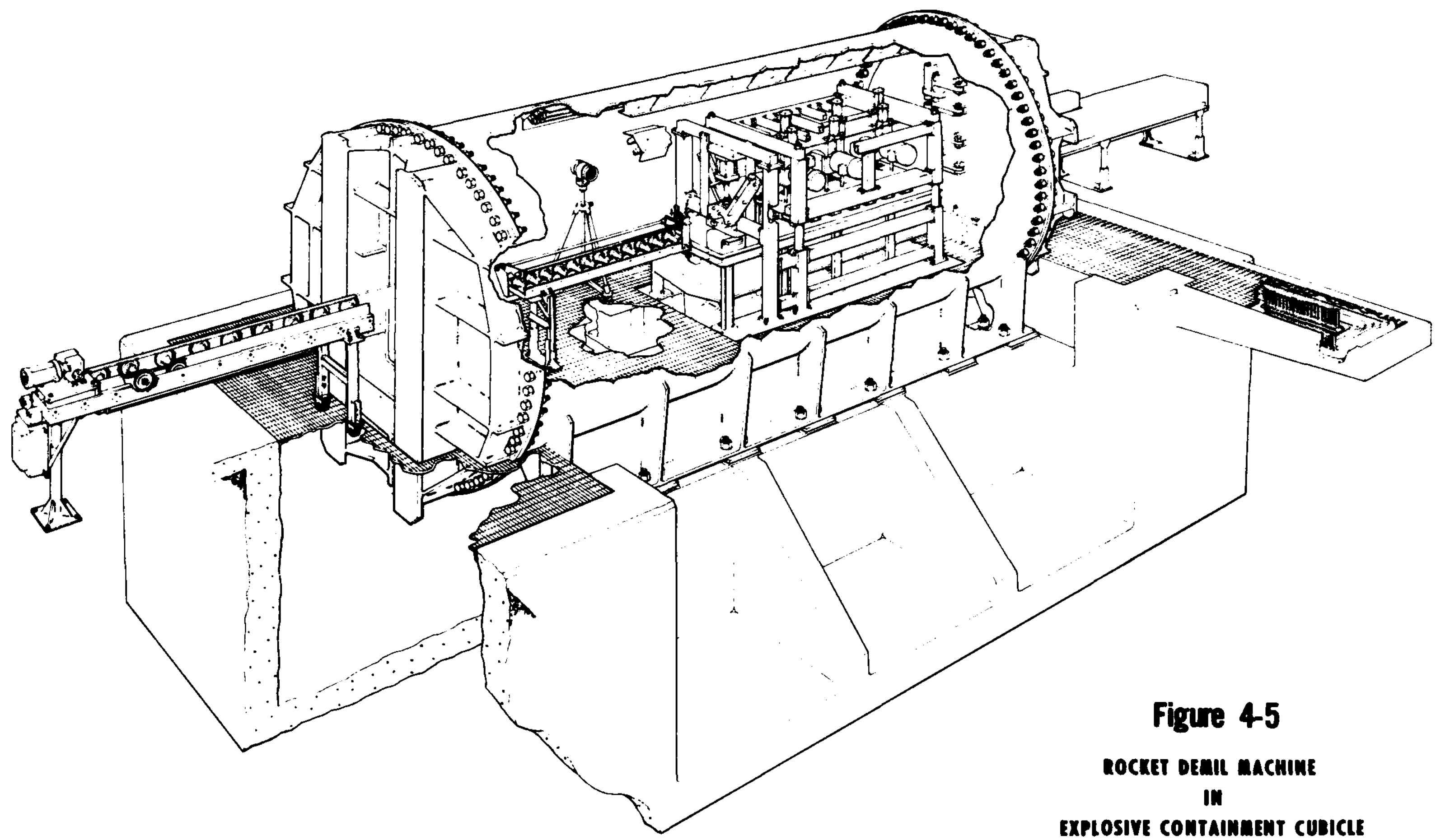

Figure 4-5

ROCKET DEMIL MACHINE
IN
EXPLOSIVE CONTAINMENT CUBICLE

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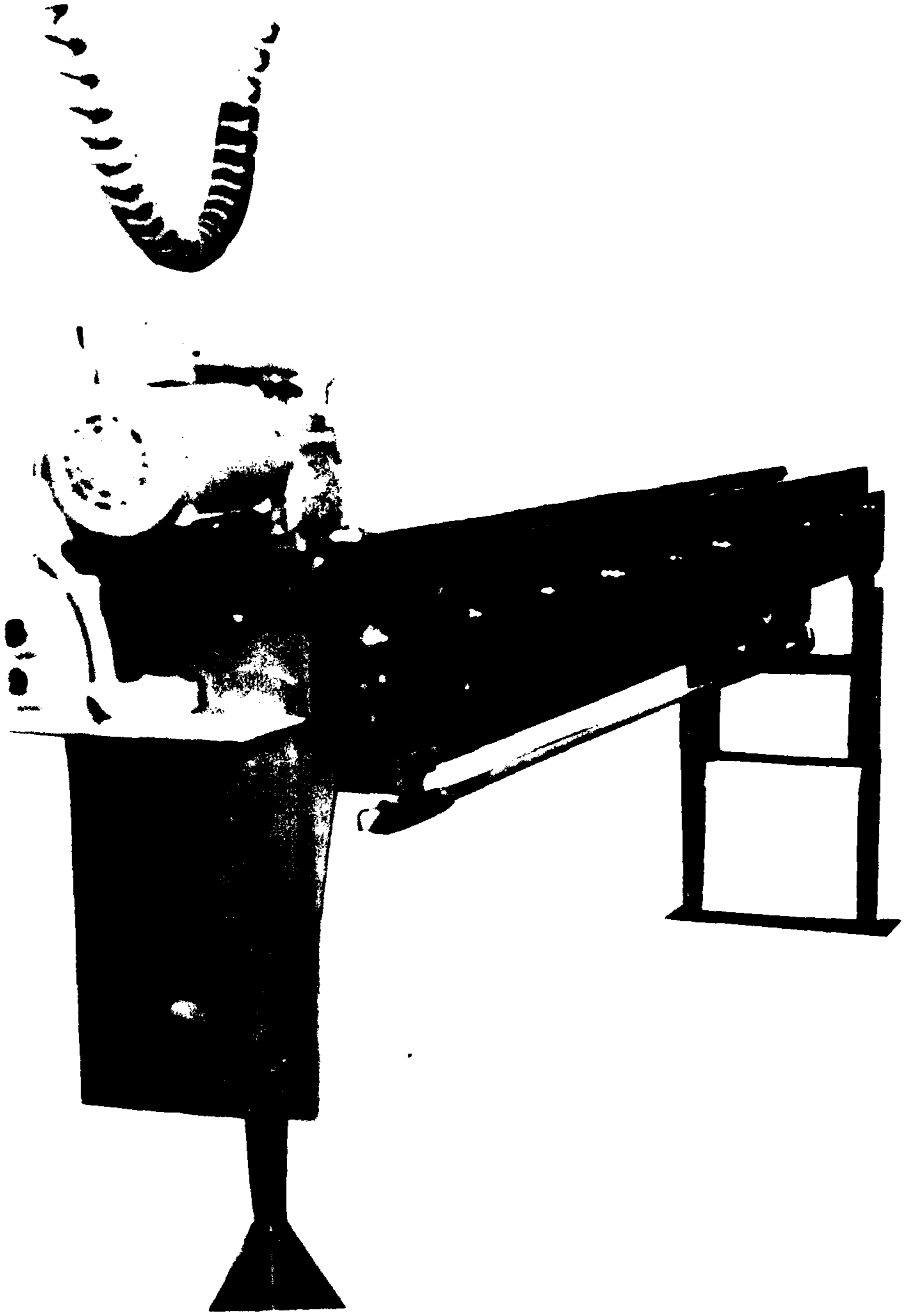


FIGURE 4-6 ECC ROCKET INPUT CONVEYOR

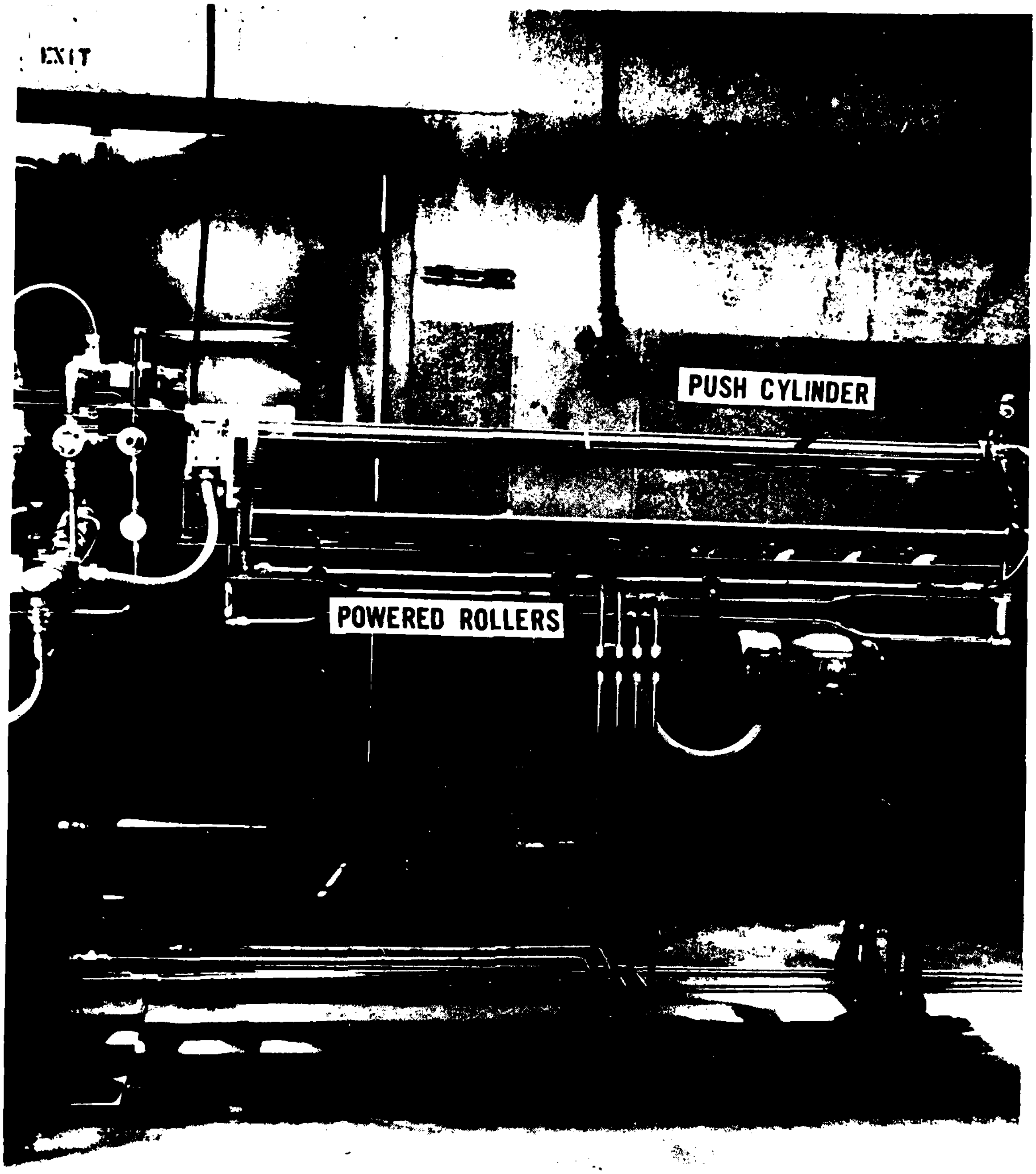


FIGURE 4-7 RDM INPUT CONVEYOR

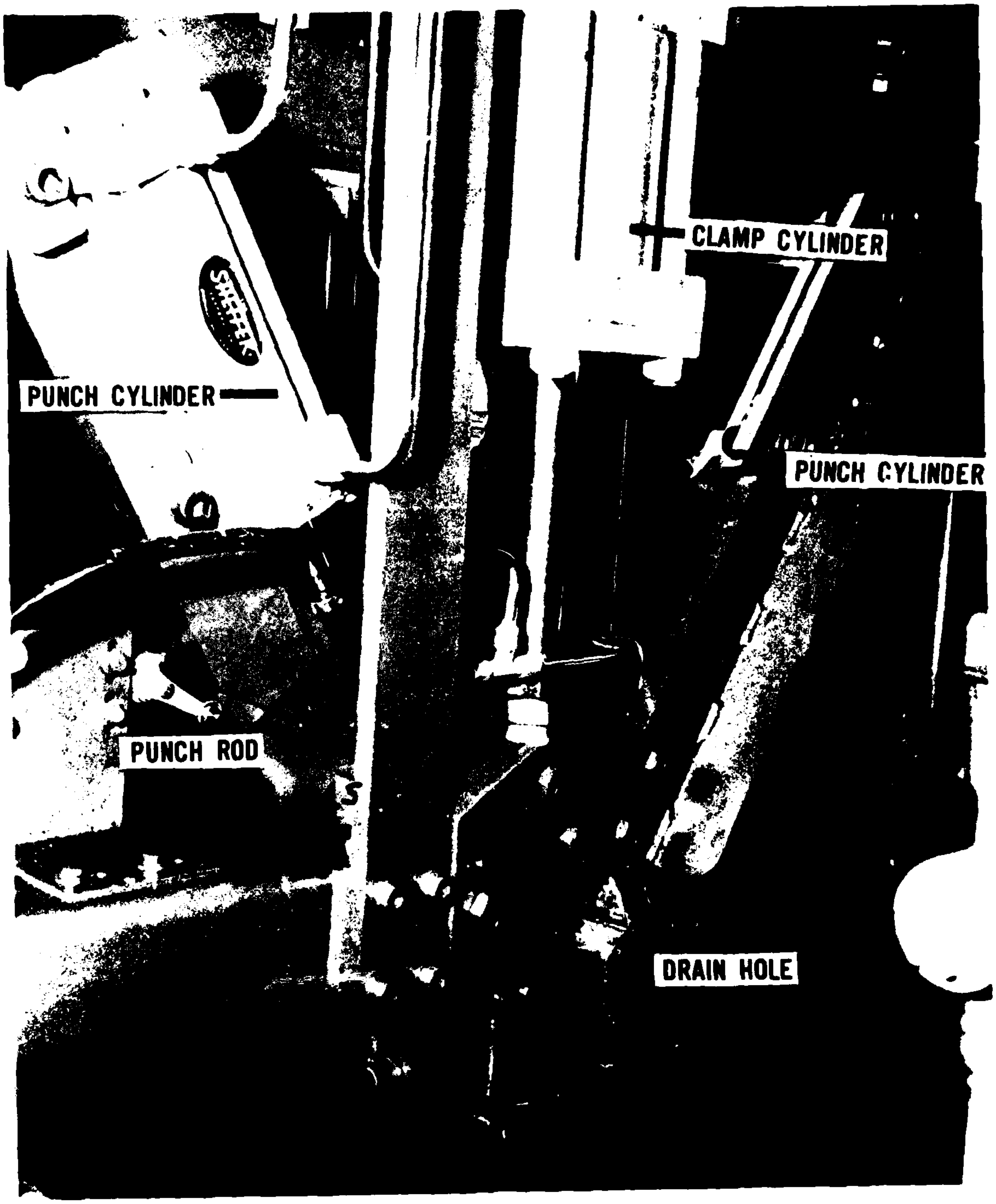


FIGURE 4-8 ROCKET PUNCH AND DRAIN STATION

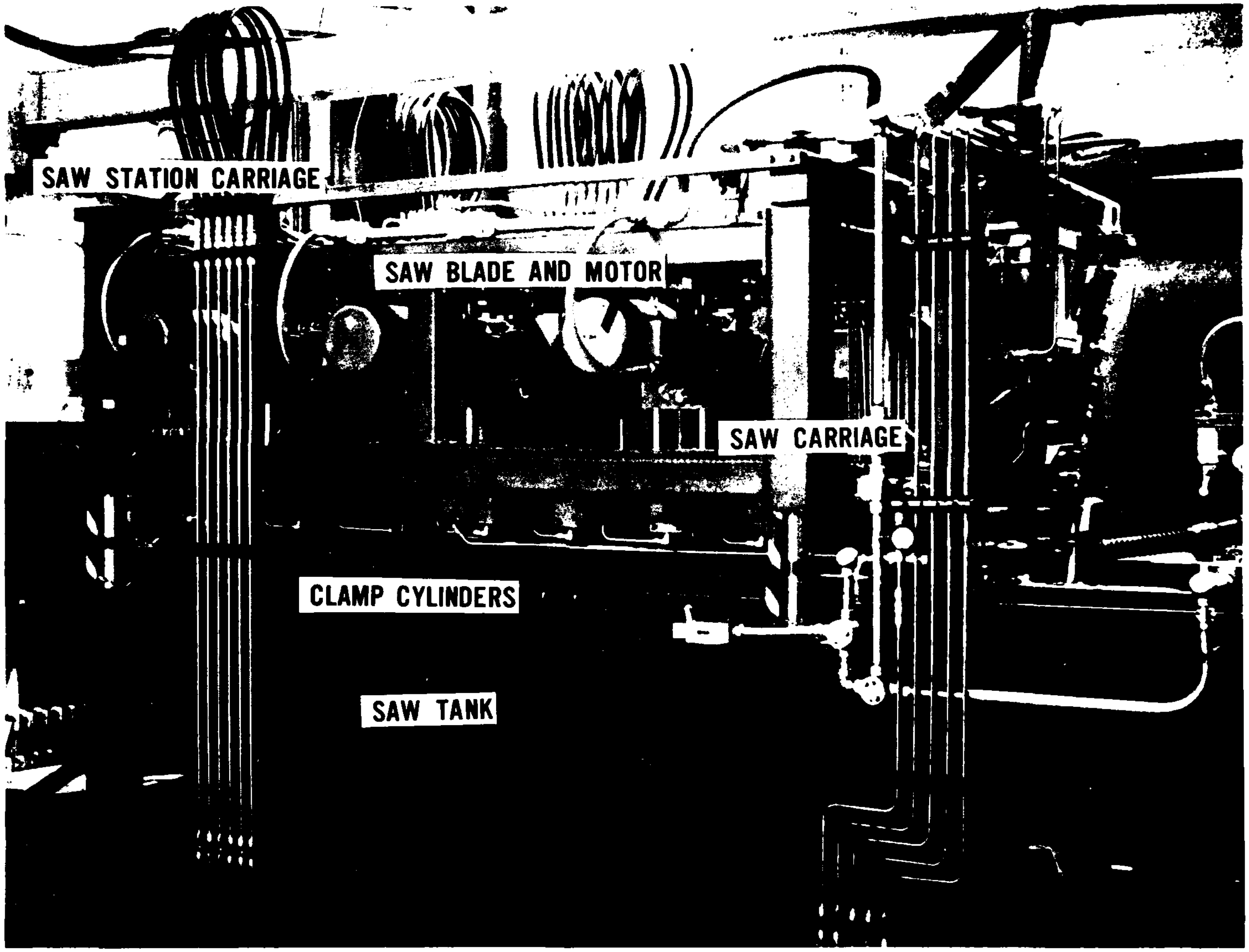


FIGURE 4-9 ROCKET SAW STATION

carriage mounted above a saw tank that contains decon solution (sodium carbonate) and a lubricant. When processing GB-filled rockets and water when processing VX-filled rockets.

(5) ECC discharge and segregator conveyor. This conveyor is installed in the ECC housing between the ECC and the Deactivation Furnace input conveyor. It consists of a moveable tray actuated by a hydraulic cylinder. The moveable tray extends into the ECC to receive the cut up rocket. When retracted, the tray sits between a segregator and a belt conveyor. The segregator, shown in Figure 4-10, consists of a series of computer controlled pneumatic cylinders that push the rocket sections from the moveable tray onto the belt conveyor. The belt conveyor is a conductive rubber material with sides approximately 3 inches high molded to a flat bed to assure containment of propellant particles. The conveyor is enclosed within a ventilated shroud to prevent release of agent vapors. The belt and supporting rollers are designed to prevent a friction hazard when handling propellant and explosives. The belt and the shroud are not shown in Figure 4-10, which represents an earlier model of this conveyor.

c. Operation.

(1) ECC rocket input conveyor. M55 rockets are packaged in plastic reinforced fiberglass shipping/firing tube containers. They are processed through the RDM motor end first while still in the container.

The Unpack Area operator places the rocket on the ECC input conveyor and operates a switch to signal the computer that the conveyor is loaded. A sensor on the conveyor signals the computer whether the rocket is properly positioned motor end first.

The ECC item-in door opens and the ECC input conveyor extends into the ECC mating with the RDM input conveyor. The powered rollers on both conveyors start.

(2) RDM input conveyor. The rocket moves from the ECC input conveyor, onto the RDM input conveyor, through the open punch clamps onto the raised idler rollers in the saw station. It continues forward on the idler rollers passing through four sets of normally open clamp jaws until it reaches the fifth set of normally closed clamp jaws. The rocket is now in the proper position for punching and draining.

The powered rollers on both conveyors stop and the ECC input conveyor retracts back to its original position in the Unpack Area airlock ready to receive the next rocket. The ECC item-in and vent air doors both close.

(3) Punch and drain station. The idler rollers in the saw station lower, positioning the rocket in the bottom jaw of the punch and drain

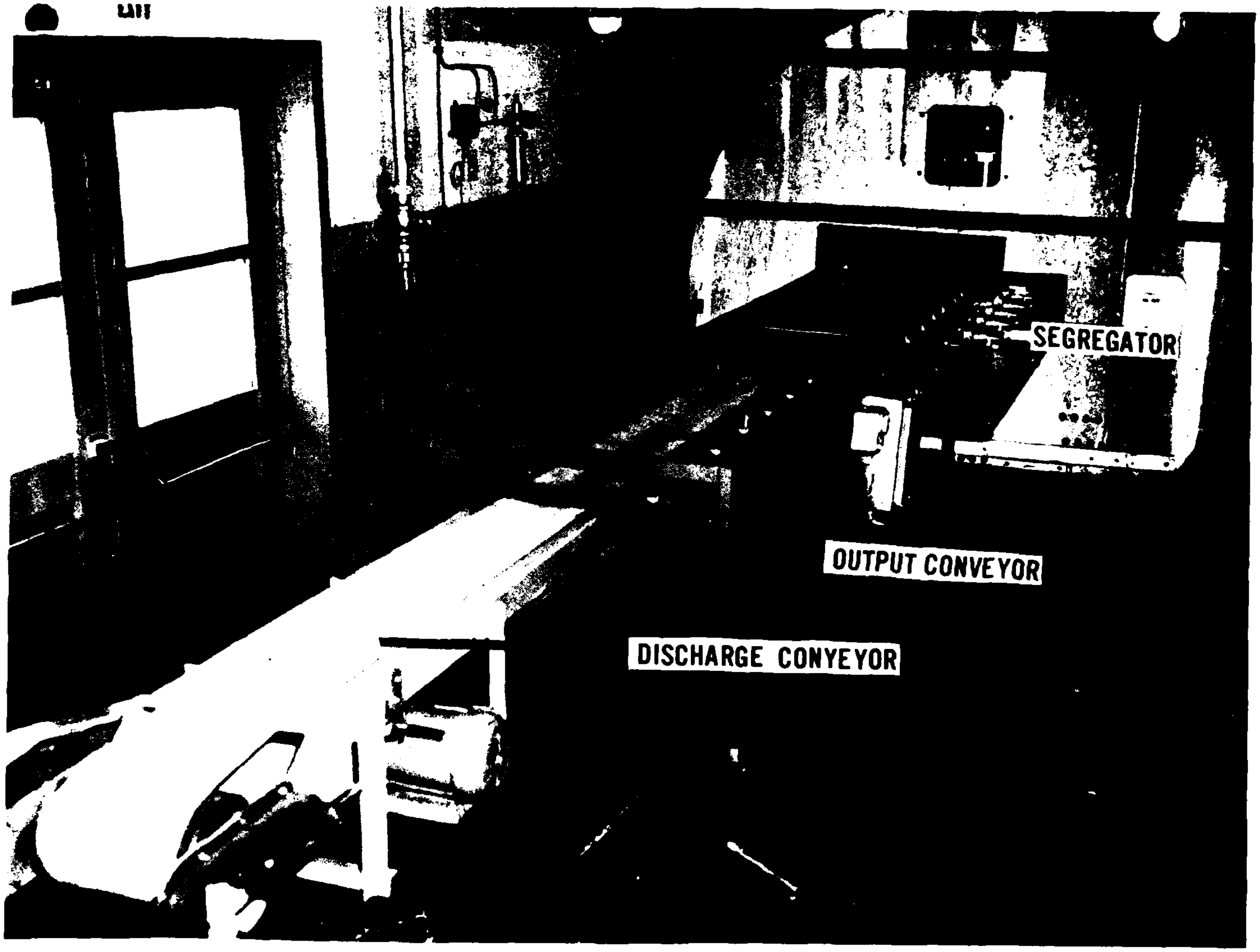


FIGURE 4-10 ECC ROCKET DISCHARGE & SEGREGATOR CONVEYOR

station clamp. The top clamp jaw lowers compressing the fiberglass container tightly against the warhead skin thus minimizing agent leakage during the drain sequence.

The two punches extend down, piercing both the top and bottom of the fiberglass tube and warhead skin. A strainer drawer in the agent catch tank collects the fiberglass and metal tabs punched out by the punch rods. The punches then retract. Air pressure is applied through the top punch holes to expedite agent draining. Complete draining is ascertained using a differential pressure switch which compares the applied air pressure to the pressure in the agent catch tank. Equal pressure indicates draining is complete.

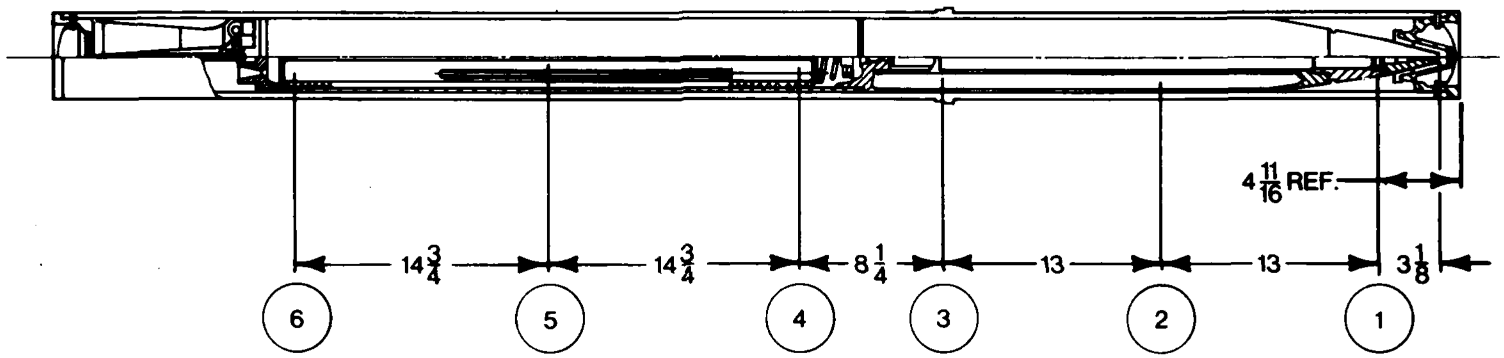
The catch tank agent valve then opens and the residual air pressure raises the agent to the high point in the agent transfer line from which the agent gravity drains to the ADS. The agent line high point is at the ECC housing. A low level ultrasonic sensor in the agent catch tank signals the computer when the tank is empty. After the tank is empty, a vacuum source is applied to the agent tank to establish a negative pressure relative to the ECC and the rocket is unclamped. The vacuum source continues to draw air through the punch station acting as a localized ventilation system until the next rocket is clamped in place.

(4) Saw station. The rocket is moved into the saw station. The fifth set of clamp jaws, that stopped the rocket in the punch station, open. The four idler rollers raise to lift the rocket out of the punch clamp jaw. The push cylinder on the RDM input conveyor pivots down until it is in line with the rocket. The push cylinder extends pushing the rocket forward on the idler rollers until the rocket hits a positive stop on the saw station carriage. The push cylinder retracts, then pivots back up to its original position.

The seven sets of hydraulic clamps close, holding the rocker rigidly below the saw blades. The idler rollers lower away from the rocket. The set of impaling punches on the second set of clamps extend, punching through the warhead skin and on into the rocket burster well to support the burster during sawing. The set of impaling punches adjacent to the fourth set of clamps extend, staking the motor body into the propellant grain so the grain section cannot slide out of the motor section after sawing is completed.

The saw carriage moves vertically on four corner bolster rods as hydraulic cylinders at each end of the carriage are actuated. As the saw carriage is lowered, the clamp and impaled rocket is submerged in the tank. The fluid in the tank decontaminates GB-filled rockets, suppresses sparks generated by sawing and cools the saw blades.

The saws do not start to cut until the computer has been notified that the agent catch tank drain sequence is completed. At that time, the hydraulic saw feed cylinders lower the saws to cut through the rocket at preset feed rates. When limit switches sense that all six saw cuts are completed, the saws retract and the saw carriage raises out of the tank. Figure 4-11 shows the location of each saw cut on the rocket.



NOTE:
CUT LOCATIONS ARE SHOWN IN RELATION TO ROCKET.
CUT LOCATION RELATIVE TO CASE MAY VARY SLIGHTLY
DUE TO VARIABLE CASE–TO–ROCKET RELATIONSHIP.

FIGURE 4-11 M-55 ROCKET WITH SAW CUT LOCATIONS

When processing GB-filled rockets, 50 gallons of the sodium carbonate solution in the saw tank is pumped through filters located in the ECC housing to remove metal particles and then to the decon hold tank at the same time that 50 gallons are pumped from the decon hold tank to the saw tank. This is done after processing every two rockets. At the end of each shift, the saw tank is emptied into the decon hold tank. In addition, the saw tank solution is recirculated within the ECC during the processing of each rocket. The hold tank solution is checked for pH and then pumped to the Explosive Treatment System (ETS). In the ETS, the solution is pumped through charcoal adsorption columns to remove dissolved explosives. The filtrate is then pumped to the waste neutralization tank in the Agent Destruction System for certification by checking for five percent excess sodium hydroxide/carbonate. The sodium carbonate solution used for make-up in the saw tank is prepared in the ETS.

When processing VX-filled rockets, the VX contaminated water in the saw tank is first pumped out of the ECC through filters to a mixing tank in the ECC housing where it is mixed with calcium hypochlorite for neutralization. The fluid is then processed through the ETS to the ADS as with the GB rockets.

As soon as the saw sequence is completed, the ECC vent air door opens. As soon as the vent door is opened, sequences are initiated to remove the sectionalized rocket and to bring in the next rocket.

(5) ECC discharge and segregating conveyor. The ECC item-out and item-in doors open. The moveable tray on the ECC discharge and segregating conveyor extends into the ECC to a position under the sectionalized rocket. The seven pairs of hydraulic clamps holding the rocket sections open, releasing the rocket sections onto the conveyor tray. The conveyor tray retracts to its original position and the ECC item-out door closes.

The segregator pushes the rocket sections one at a time off the conveyor tray onto the belt conveyor portion of the discharge and segregating conveyor. The order of selection and time interval between each rocket section is based upon the quantity of explosives or propellant in each rocket section. An array of switches on the segregator assure only one rocket section at a time is pushed onto the discharge conveyor. The rocket sections are carried by the ECC discharge belt conveyor to the Deactivation Furnace input conveyor.

The Deactivation Furnace input conveyor is a conductive rubber belt with molded sides and flights comparable to the ECC discharge conveyor. It carries the rocket sections to a tipping valve that acts as a transfer airlock through the common wall between the ECC housing and the Deactivation Furnace housing. The double tipping valve feeds the rocket sections into the Deactivation Furnace feed chute. The same Deactivation

Furnace input conveyor and tipping valve is used for all munition explosive components that are processed through the ECC to the Deactivation Furnace.

d. Safety. All RDM operations are computer controlled and monitored to eliminate operator error. The input conveyor is interlocked so the computer cannot feed rockets warhead end first into the ECC. The punch and drain operation cannot begin until all the ECC doors are closed and locked. The saw operation cannot begin until the drained agent has been pumped out of the ECC. The ECC input and output doors cannot be opened until the ECC ventilation door is open.

The saw motors are computer monitored to detect dull or stalled saw blades. The saw blades will be exchanged at regular preventative maintenance intervals that were determined while sawing more than 2000 simulant filled live rockets using the submerged sawing concept. The pilot test sawing of such a large quantity of rockets without an explosive or fire related incident indicates the submerged sawing operation is a safe concept. The rocket discharge and segregator conveyor contains a belt with sides to assure that explosive dust and particles are retained on the conveyor.

Maintenance personnel will wear level A protective clothing and be under constant television surveillance when in the ECC.

e. References. The following references are contained in Inclosure 11.

(1) Test Report CAMDS 6-1. "M55 Rocket Burster Furnace Deactivation", 5 Dec 1969, by Ammunition Equipment Office (AEO), Tooele Army Depot (TEAD). Test to assure rocket bursters could be safely deactivated by burning.

(2) Test Report CAMDS 6-2. "M55 Rocket Propellant Test", 1 Jun 1970, by AEO-TEAD. A test to determine if rocket propellant could be initiated to detonate high order.

(3) Test Report CAMDS 6-4. "M61 Rocket Saw Test", 22 Sep 1970, by AEO-TEAD. A test to determine if a rocket fuze booster could be safely sawed.

(4) Test Report CAMDS 6-5. "M61 Rocket Cold Saw Summary Test Report", 3 Mar 1971, by AEO-TEAD. A summary report of all rocket saw operations to date.

(5) Test Report CAMDS 6-6. "Sludge Generation Test", 15 Sep 1971, by AEO-TEAD. A test to determine the rate of explosive sludge accumulation in the saw tank and requirements for preventative maintenance.

(6) Test Report CAMDS 6-7. "Explosive Accumulation at Segregator", by AEO-TEAD. A test to determine the rate of explosive material accumulation at the segregator and requirements for preventative maintenance.

(7) Test Report CAMDS 6-8. "M55 Rocket Casing Burn Test", 2 May 1972, by AEO-TEAD. A test to determine if the fiberglass casing would burn adequately without the additional heat of burning propellant.

(8) Test Report CAMDS 6-9. "Propellant Ignition Test", 18 Aug 1972, by AEO-TEAD. A test igniting submerged rocket motors.

(9) Test Report CAMDS 6-10. "Rocket Drain Test", 31 Oct 1972, by AEO-TEAD. A test to determine efficiency of draining rockets by applying air pressure after punching rocket.

(10) Test Report CAMDS 6-11. "Drain Test on Pressurized Rockets", 9 Nov 1972, by AEO-TEAD. A test to determine effects of punching a rocket having internal pressure.

(11) Test Report CAMDS 6-12. "Maintenance of RDM While Wearing Rubber", 26 Jun 1973, by AEO-TEAD. A test to determine maintainability of RDM in level A protective clothing.

Furnace input conveyor and tipping valve is used for all munition explosive components that are processed through the ECC to the Deactivation Furnace.

d. Safety. All RDM operations are computer controlled and monitored to eliminate operator error. The input conveyor is interlocked so the computer cannot feed rockets warhead end first into the ECC. The punch and drain operation cannot begin until all the ECC doors are closed and locked. The saw operation cannot begin until the drained agent has been pumped out of the ECC. The ECC input and output doors cannot be opened until the ECC ventilation door is open.

The saw motors are computer monitored to detect dull or stalled saw blades. The saw blades will be exchanged at regular preventative maintenance intervals that were determined while sawing more than 2000 simulant filled live rockets using the submerged sawing concept. The pilot test sawing of such a large quantity of rockets without an explosive or fire related incident indicates the submerged sawing operation is a safe concept. The rocket discharge and segregator conveyor contains a belt with sides to assure that explosive dust and particles are retained on the conveyor.

Maintenance personnel will wear level A protective clothing and be under constant television surveillance when in the ECC.

e. References. The following references are contained in Inclosure 11.

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(2) Test Report CAMDS 6-2. "M55 Rocket Propellant Test", 1 Jun 1970, by AEO-TEAD. A test to determine if rocket propellant could be initiated to detonate high order.

(3) Test Report CAMDS 6-4. "M61 Rocket Saw Test", 22 Sep 1970, by AEO-TEAD. A test to determine if a rocket fuze booster could be safely sawed.

(4) Test Report CAMDS 6-5. "M61 Rocket Cold Saw Summary Test Report", 3 Mar 1971, by AEO-TEAD. A summary report of all rocket saw operations to date.

(5) Test Report CAMDS 6-6. "Sludge Generation Test", 15 Sep 1971, by AEO-TEAD. A test to determine the rate of explosive sludge accumulation in the saw tank and requirements for preventative maintenance.

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(8) Test Report CAMDS 6-9. "Propellant Ignition Test", 18 Aug 1972, by AEO-TEAD. A test igniting submerged rocket motors.

(9) Test Report CAMDS 6-10. "Rocket Drain Test", 31 Oct 1972, by AEO-TEAD. A test to determine efficiency of draining rockets by applying air pressure after punching rocket.

(10) Test Report CAMDS 6-11. "Drain Test on Pressurized Rockets", 9 Nov 1972, by AEO-TEAD. A test to determine effects of punching a rocket having internal pressure.

(11) Test Report CAMDS 6-12. "Maintenance of RDM While Wearing Rubber", 26 Jun 1973, by AEO-TEAD. A test to determine maintainability of RDM in level A protective clothing.

4-6 PROJECTILE DEMIL MACHINE (PDM)

a. Purpose. The PDM is used to remove the explosive components from projectiles and cut the bursters into sizes suitable for processing through the Deactivation Furnace. The equipment is designed to process all of the following projectiles containing bursters, but only items 2, 3, and 4 are stored at Tooele Army Depot with bursters installed.

(1) 105mm-M60

(2) 105mm-M360

(3) 155mm-M104

(4) 155mm-M110

(5) 155mm-M122

(6) 155mm-M121A1

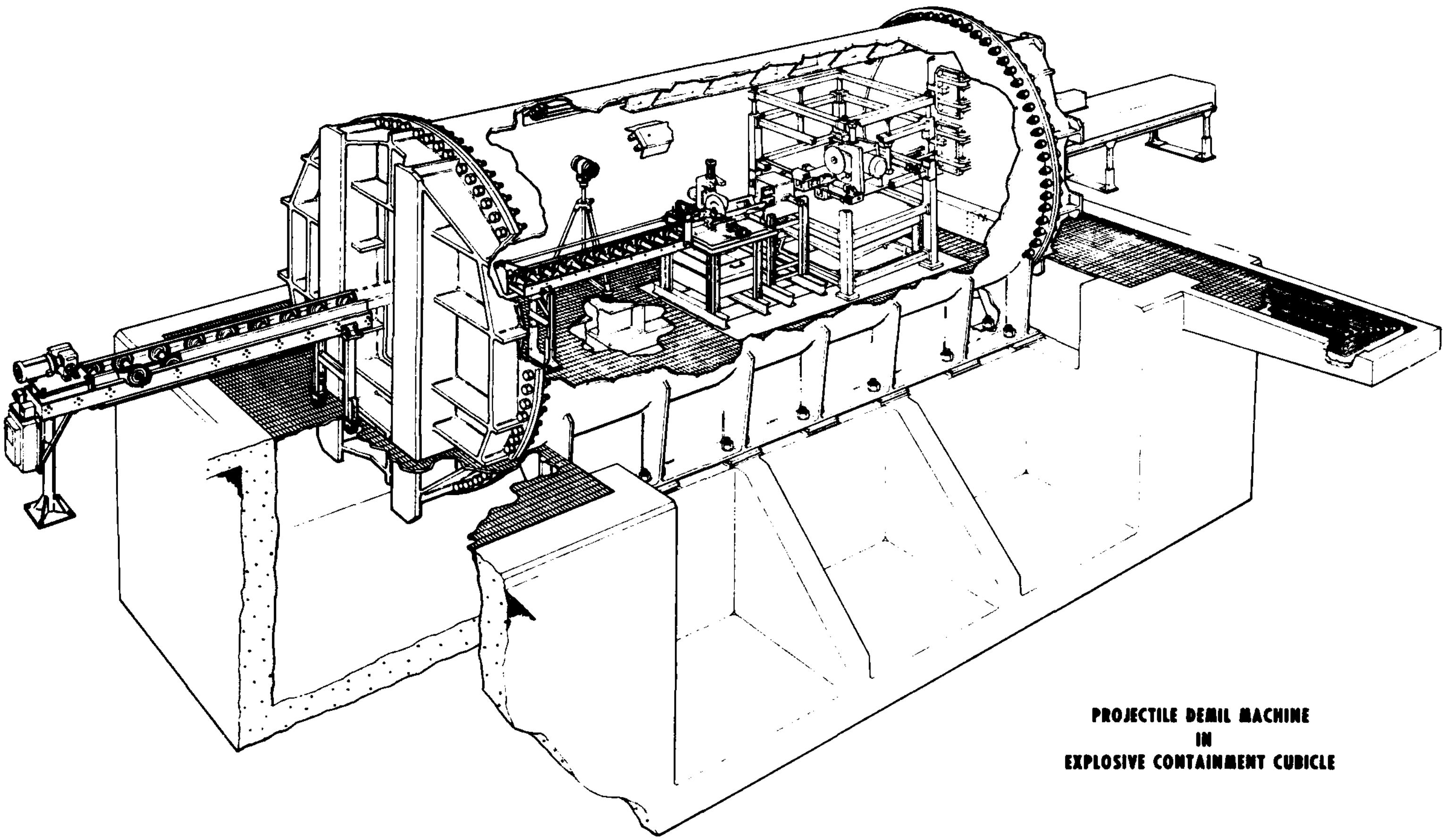
(7) 155mm-M121

(8) 8-inch-M426

b. Description. Figure 4-12 is an artist's concept of the PDM installed in the Explosive Containment Cubicle (ECC). The PDM is a multi-station machine designed to process a variety of projectiles one type at a time. The PDM will require the replacement of some parts such as clamp jaws and cylinder stops and the adjustment of other parts such as limit switches when changing over from one type of munition to another type. The PDM consists of the following conveyors and stations.

(1) ECC projectile input conveyor (Figure 4-12). This conveyor, located in the airlock of the Unpack Area, is an electric motor powered roller conveyor with a sliding bed actuated by a hydraulic cylinder. The sliding bed is used to transfer the projectile from the Unpack Area into the ECC. The powered rollers are used to transfer the projectile from the ECC conveyor onto the PDM input conveyor.

(2) PDM input conveyor (Figure 4-13). This conveyor, located in the ECC, is an electric motor powered roller conveyor with two pivoting hydraulic push cylinders, one long, one short, mounted on each side of the conveyor frame. The powered rollers are used to transfer the projectile from the ECC input conveyor to a position in front of the push cylinders. The short push cylinder is used to push the projectile into the projectile saw station. The long push cylinder is used to push the projectile into the burster removal station.



PROJECTILE DEMIL MACHINE
IN
EXPLOSIVE CONTAINMENT CUBICLE

Figure 4-12

APRIL 1975

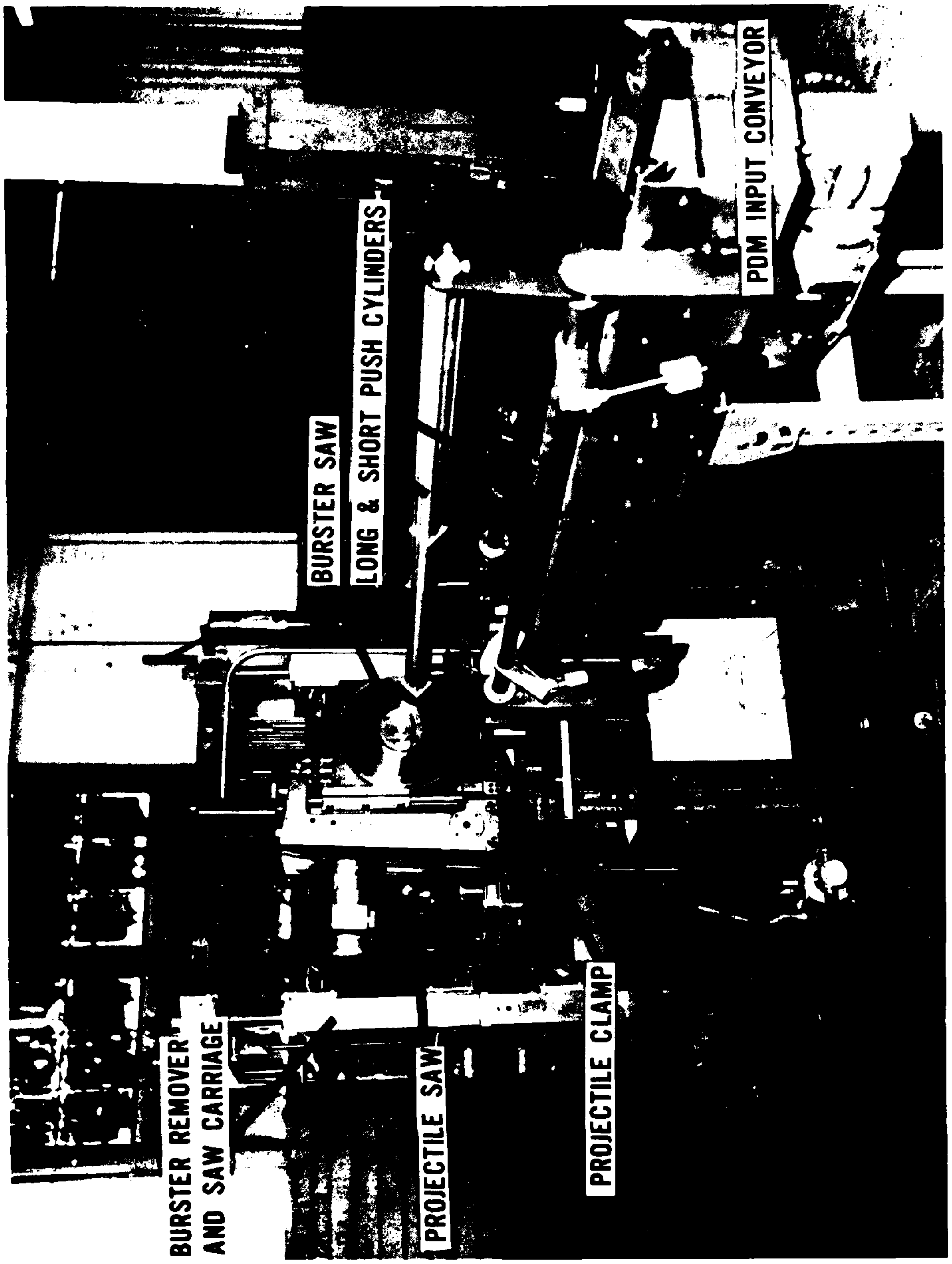


FIGURE 4-13 PROJECTILE DEMIL MACHINE

(3) Projectile saw station (Figure 4-14). This station consists of a set of horizontal operating hydraulic clamps to hold the projectile and a vertical operating radial cold saw. It is used to cut the fuze or nose closure plug off the projectile. An open top tank filled with a solution of coolant water and cutting compound is located below the saw station. The tank catches the saw cuttings and is the reservoir for a coolant pump.

(4) Supplementary charge removal station. There are no burstered projectiles stored at TEAD containing supplementary charges but the PDM has been designed to process them. The station consists of a pivoting cylinder mounted adjacent to the saw station clamps. An electromagnet is attached to the cylinder ram. The cylinder, when pivoted down, is in line with the cut off end of the projectile while it is clamped in the saw station.

(5) Nose closure/fuze transfer conveyor. This is an electric motor driven belt conveyor located between the projectile saw station and the burster removal station. It operates at a right angle to the flow of the projectile through the ECC.

(6) Burster removal station (Figure 4-15). This station consists of several idler rollers to support the projectile as it enters the station and a set of horizontal operating hydraulic clamp jaws to hold the projectile. A hydraulic cylinder raises and lowers the idler roller carriage.

A burster pulling device is mounted on a carriage that moves vertically and side ways in relation to the projectile clamps. The burster pulling device works on a differential pressure (delta P) principle illustrated in Figure 4-16. The burster puller uses three cylinders. One cylinder to extend and retract the delta P head and burster pull tube as one unit, a second cylinder to extend and retract the burster pull tube in the delta P head and a third cylinder mounted on the side of the delta P head to clamp the burster inside the delta P head.

(7) Burster saw station (Figure 4-17). The components of the burster saw station are mounted on the same moveable carriage as the burster pulling device. There are two sets of horizontal operating hydraulic clamps to hold the burster and a vertical operating radial cold saw to saw the burster. An open top tank containing cooling water is located below the burster saw station. The tank catches the saw cuttings and is the reservoir for a coolant pump.

(8) Burster transfer conveyor. This is an electric motor driven belt conveyor similar to the nose closure transfer conveyor. It sits parallel to the nose closure transfer conveyor in line with the burster saw station.

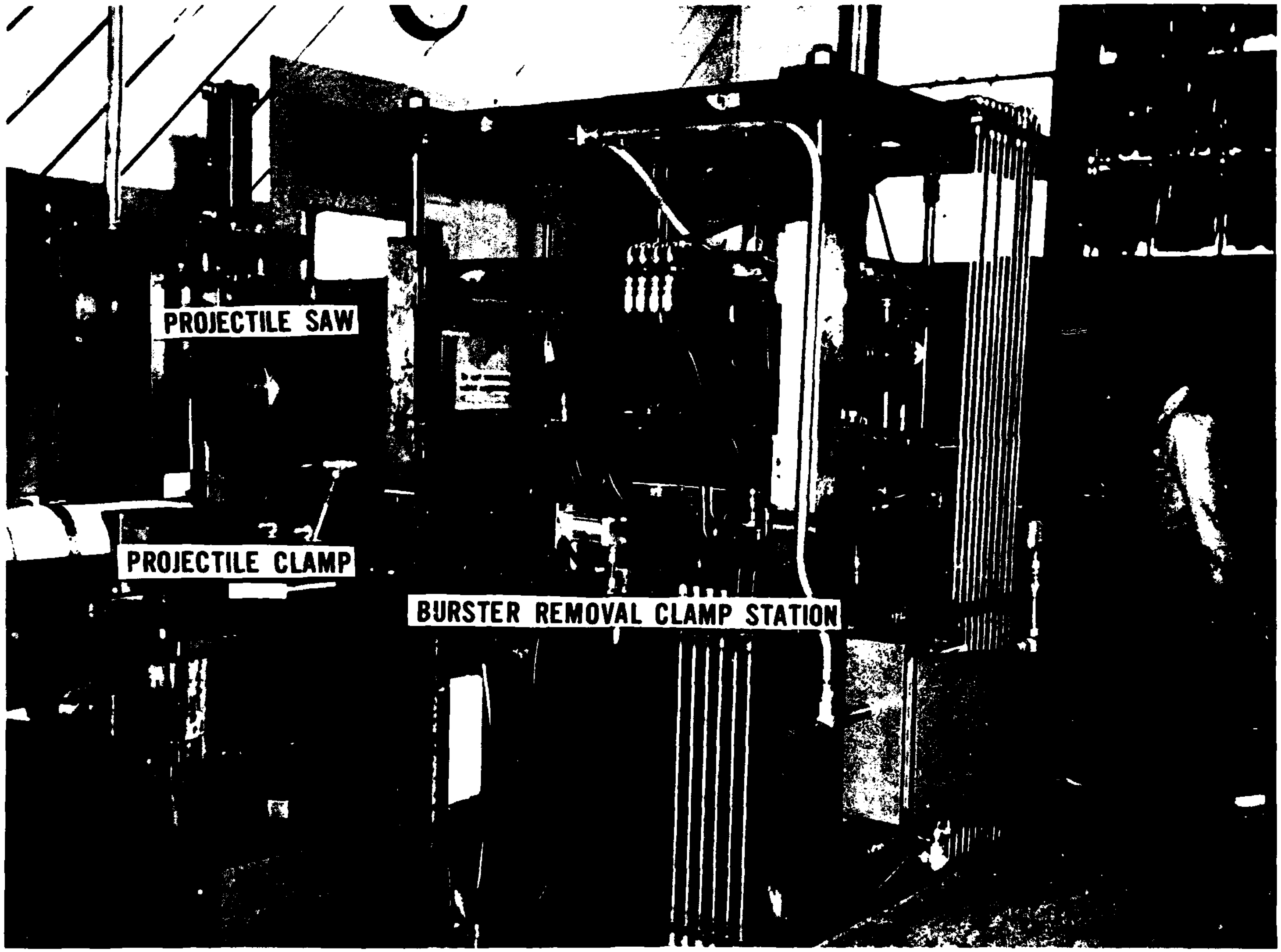


FIGURE 4-14 PROJECTILE SAW STATION

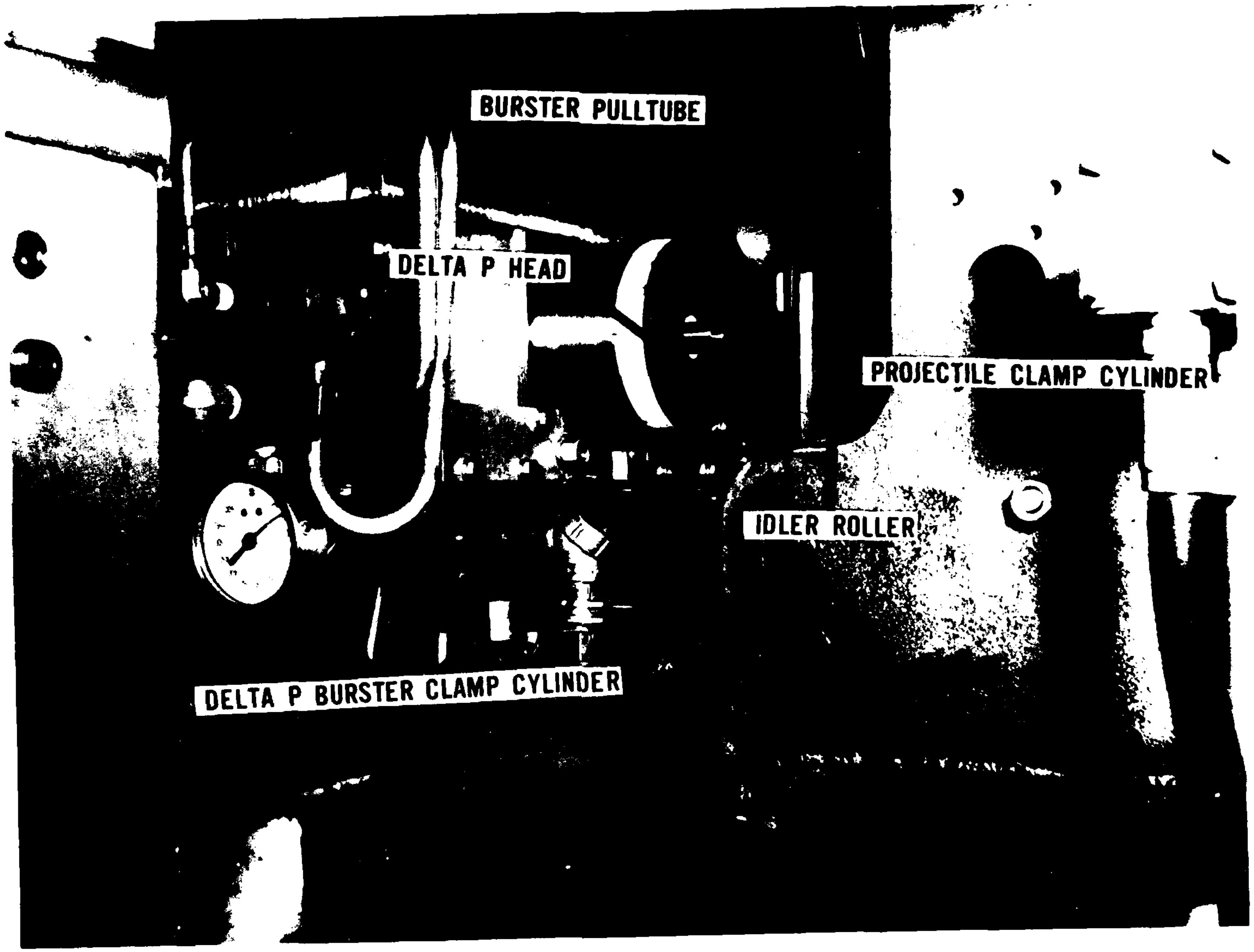


FIGURE 4-15 BURSTER REMOVAL STATION

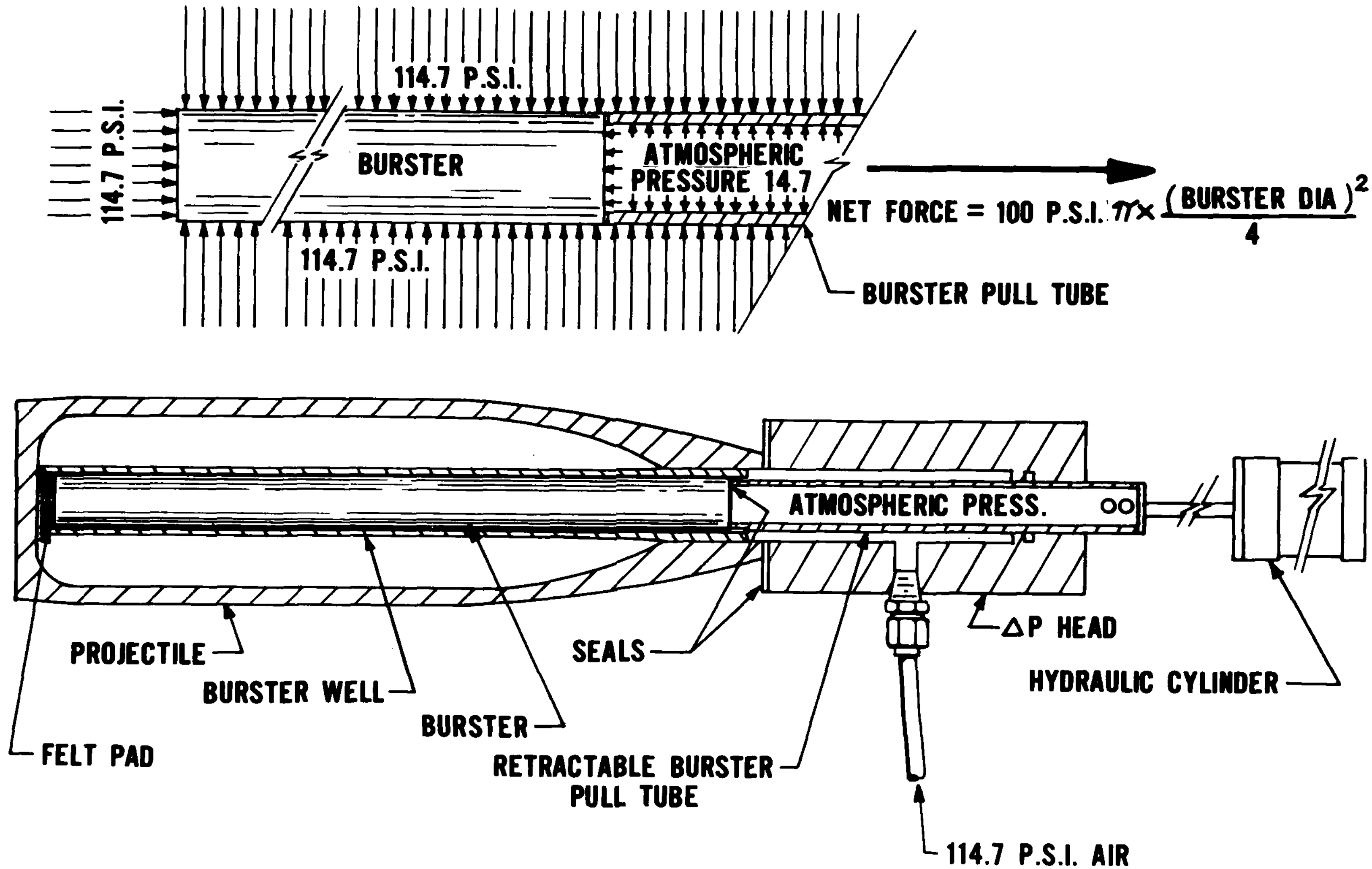


Figure 4-16 **DELTA (Δ) P PRINCIPLE**

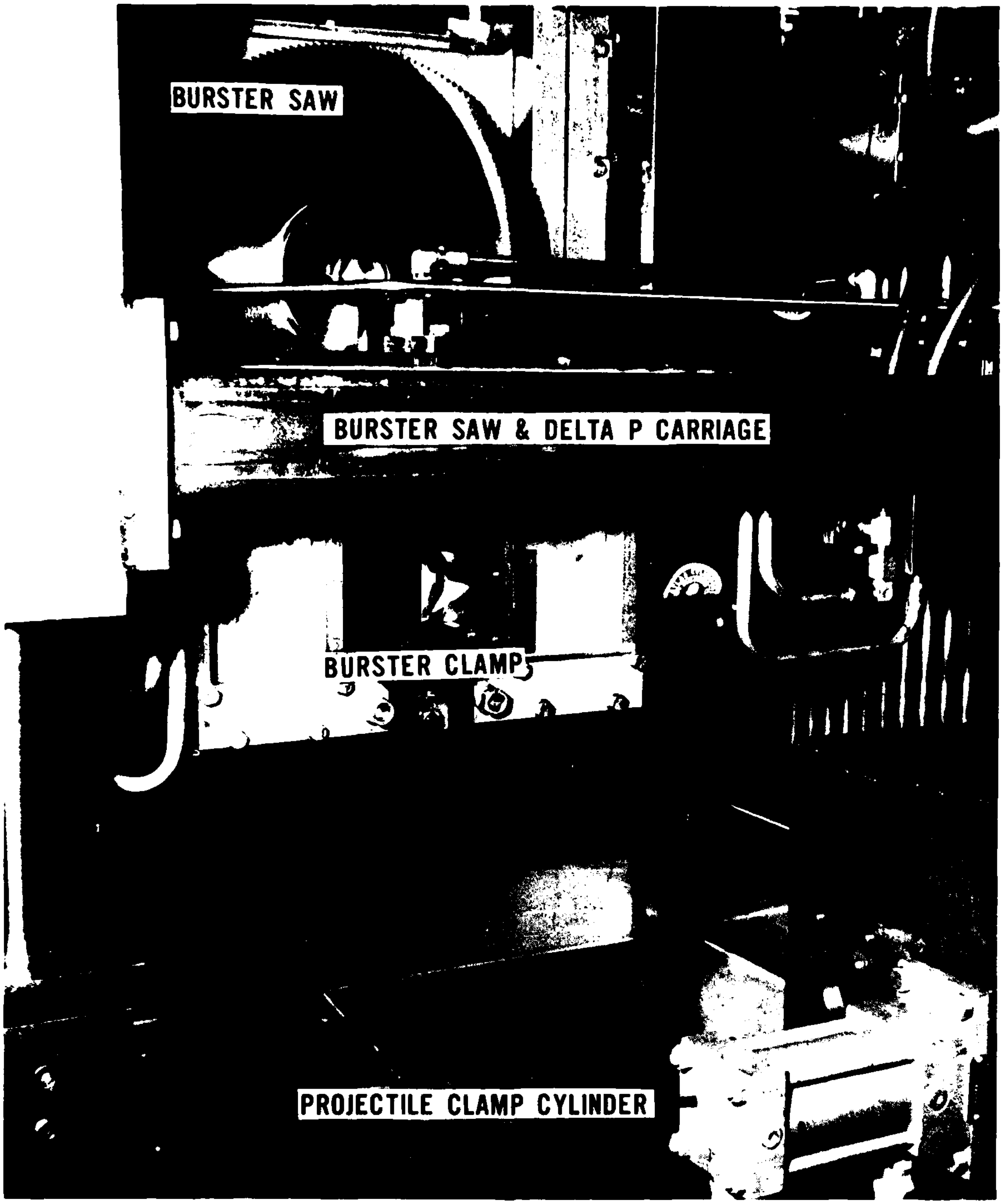


FIGURE 4-17 BURSTER SAW STATION

(9) Projectile ECC discharge conveyor. This conveyor is located outside of the ECC in the ECC housing in line with the ECC item-out door. It consists of a single tray, sliding bed conveyor actuated by a hydraulic cylinder. A hydraulic push cylinder is mounted on one side of the conveyor frame and a gravity operated idler roller conveyor is attached to the other side. The idler roller conveyor mates with the input conveyor to the Projectile Disassembly Facility.

(10) Burster output conveyor. This conveyor is located adjacent to the projectile ECC discharge conveyor in line with the ECC high explosives out door. It is a multitray, sliding bed conveyor actuated by a hydraulic cylinder. Each tray is hinged so it can be dumped separately by cylinders attached to the conveyor frame.

(11) High Explosive (HE) ECC discharge conveyor. This conveyor is located along side the burster output conveyor. It is an electric motor driven flat belt conveyor. It empties onto the Deactivation Furnace input conveyor.

e. Operation.

(1) ECC input conveyor. The Unpack Area operator places a projectile nose-end first on the ECC input conveyor, then signals the computer the conveyor is loaded. The ECC item-in door opens and the input conveyor extends into the ECC until it mates with the PDM input conveyor. The powered rollers on both conveyors start and the projectile moves from the ECC input conveyor onto the PDM input conveyor. The rollers on the input conveyor stop and the conveyor retracts out of the ECC back into the Unpack Area ready to receive the next projectile. The ECC item-in and vent-air doors both close.

(2) PDM input conveyor. The projectile moves forward on the PDM input conveyor until it is ahead of the short push cylinder. The conveyor rollers stop and the short push cylinder pivots down until it is in line with the projectile. The cylinder extends, pushing the projectile into the projectile saw station. The short cylinder is a double ended cylinder with a stop sleeve mounted on the rear shaft. When the cylinder stalls out, the projectile is in the proper sawing location. The push cylinder retracts and pivots up to its original position.

(3) Projectile saw station (Figure 4-14). The saw station hydraulic clamps close to hold the projectile. The saw motor, saw feed and saw coolant pump turn on. The saw lowers to cut the fuze or nose closure plug from the projectile. The cut is made through the fuze booster to expose the booster pellet so it will burn instead of detonate in the Deactivation Furnace. A portion of the solution in the coolant tank is periodically pumped through the sludge filters in the ECC housing where the saw cuttings are filtered out. The cuttings are processed through the Deactivation Furnace. The filtrate is collected in the decon hold

tank; decon solution is added to the necessary pH level and the solution is pumped through the Explosive Treatment System charcoal columns to the Agent Destruction System (ADS) waste neutralization tank for certification and ultimate drying on the ADS drum dryers.

Periodically, all the coolant solution is pumped out of the tank. The remaining sludge is cleaned out and processed through the Deactivation Furnace.

The saw carriage raises and the saw motor, saw feed and coolant pump shut off. The cut off end of the projectile, containing the fuze or nose closure plug, drops onto the saw bed in front of the projectile. The rear end of the fuze booster normally falls out of the projectile as the saw raises. A blast of air from a nozzle aimed at the cut off end of the projectile insures the booster end piece falls out.

(4) Supplementary charge removal station. The computer will skip this next operation when CAMDS is operated at TEAD. The operation will be explained in case CAMDS and this demilitarization plan are utilized at other locations. The supplementary charge removal cylinder pivots down until it is in line with the burster well of the projectile. The cylinder pushes the cut off projectile nose section to one side as it pivots down. The cylinder extends, positioning the electromagnet against the supplementary charge which is packed in a steel cup. The electromagnet is energized and the cylinder retracts, pulling the supplementary charge out of the projectile. The electromagnet is de-energized dropping the supplementary charge in front of the projectile. The cylinder pivots up to its original position.

(5) Nose closure transfer conveyor. The projectile saw station clamps open and the long push cylinder on the PDM input conveyor pivots down in line with the projectile. The push cylinder extends, pushing the projectile from the saw station onto the idler rollers in the burster removal station. The projectile, with the cut off nose section and the booster section in front of it, slides in a trough between the saw station and the burster removal station. As the projectile moves forward, the pieces in front of the projectile fall through an opening in the trough onto the nose closure transfer conveyor which is not running at this time.

(6) Burster removal station (Figure 4-15). A positive stop on the idler roller carriage stops the projectile in the proper position in the burster removal station. The push cylinder retracts and pivots up to its original position as the hydraulic clamps close to hold the projectile. The idler roller carriage lowers away from the projectile.

The burster remover carriage moves to the extreme right and down vertically against prepositioned stops which align the burster remover with the projectile. The delta P head moves forward between the burster

saw clamps until it is against the projectile. Air pressure is applied to the delta P head and the burster pull tube extends until it is against the burster. The burster pull tube retracts, pulling the burster into the delta P head. The cylinder on the delta P head extends, clamping the burster in the delta P head.

The clamp cylinder is a double ended cylinder with a limit switch mounted on the rear end. If the burster did not pull into the delta P head, the cylinder will extend further than normal and trip the limit switch. This signals the computer that the burster did not pull and the computer will recycle the burster pull operation 10 times. If the burster still does not pull, the computer will skip the burster saw operation, remove the projectile from the ECC and then discontinue all operations until the projectile has been removed from the ECC discharge conveyor. Projectiles with stuck bursters will be placed in cans and then returned to storage until a procedure has been designed to remove the burster in some other manner.

The air to the delta P head turns off and the burster remover, with the burster clamped in it, retracts pulling the burster the rest of the way out of the projectile burster well.

(7) Burster saw station (Figure 4-17). The burster removal stops after the burster is clear of the burster well. The burster hydraulic clamps close on the burster and the clamp cylinder on the delta P head retracts to release the burster. The burster remover then retracts to its full limit.

The burster saw motor, coolant pump and saw feed turn on and cut the burster as the carriage assembly moves up and to the left extreme limits. In this position the saw cut has been completed, the saw motor, pump and feed are off and the sectioned burster is positioned above the burster transfer conveyor.

The coolant water in the tank below the burster saw station is handled in the same manner as previously explained for the solution in the tank at the projectile saw station.

(8) Burster transfer conveyor. This conveyor is not running at this time. The burster clamps open, dropping the two burster sections onto the burster transfer conveyor.

The ECC vent door opens and the ECC ventilation system pulls a negative pressure on the ECC. The ECC item-in, item-out and HE-out doors open and the operations are initiated to remove the processed projectile and to bring in the next projectile.

(9) Projectile discharge conveyor. The moveable bed of this conveyor extends through the ECC item-out door onto the idler rollers below the projectile clamped in the burster removal station. The clamps open and the projectile drops into the conveyor tray. The conveyor retracts to its original position and the ECC item-out door closes. The push cylinder mounted on the conveyor frame extends, pushing the projectile from the tray onto the idler roller section of the discharge conveyor which mates with the Projectile Disassembly Facility input conveyor.

(10) HE output conveyor. The HE output conveyor extends through the ECC HE-out door to a position so the trays on the conveyor are in line with the nose closure and burster transfer conveyors which then start and transfer the parts onto the HE output conveyor. The HE output conveyor retracts to its original position, the two transfer conveyors turn off and the HE-out door closes.

(11) HE discharge conveyor. The HE discharge conveyor runs continuously. The trays on the HE output conveyor are dumped one at a time onto the HE discharge conveyor at intervals to prevent overloading the Deactivation Furnace. The HE discharge conveyor transfers the parts to the Deactivation Furnace input conveyor.

d. Safety. All PDM operations are computer controlled to eliminate operator error. Saw operations cannot start until the ECC doors are closed and locked. The saw blade coolant suppresses sparks generated by the saw blades. Saw blades will be replaced at scheduled intervals. The explosive sludge will be removed from the saw coolant tanks at scheduled intervals. Maintenance personnel will wear level A protective clothing. Positive stops insure the projectile is precisely positioned at each process station. Cutting the burster and booster assures burning rather than detonation in the Deactivation Furnace. Conveyors handling open explosive components are designed to totally contain explosive grain and to avoid pinch points and friction which could cause fire or explosion. Extensive pilot testing was performed to insure design and concept integrity.

e. References. The following references are contained in Inclosure 11.

(1) Test Report CAMDS 15-1. "Burster Saw Test", 13 Mar 1972, by Ammunition Equipment Office (AEO), Tooele Army Depot (TEAD). Nine hundred burster cuts were made without incident.

(2) Test Report CAMDS 15-2. "Delta P Removal of Stuck Inert Bursters", Dec 1973, by AEO-TEAD. A test to determine the best operating procedures for removing stuck bursters.

(3) Test Report CAMDS 15-3. "Delta P Removal of Stuck Live Bursters", Apr 1974, by AEO-TEAD. A test to assure the Delta P process was safe.

(4) Test Report CAMDS 15-4. "Delta P Test", 4 Sep 1974, by AEO-TEAD. A confirming test on stuck bursters in agent-filled projectiles.

4-7 MINE DEMIL MACHINE (MIN)

a. Purpose. The Mine Demil Machine is used to drain the agent (VX) and remove the explosive components from M23 land mines.

b. Description. Figure 4-18 is an artist's concept of the Mine Demil Machine installed in the Explosive Containment Cubicle (ECC). Except for conveying, all operations on the mine are done in one station. The machine consists of the following major components.

(1) ECC mine input conveyor (Figure 4-19). This conveyor, located in the airlock of the Unpack Area, has a moveable bed actuated by a hydraulic cylinder. The mine cradle on the conveyor is designed with a sensor operated by the mine handle so the mine must be properly loaded before the computer can start the operations.

(2) Hydraulic clamping device (Figure 4-20). The Mine Demil Machine uses a hydraulic clamp to lift the mine off the input conveyor and to hold the mine during the punch, drain and disassembly operations. The top clamp jaw is stationary. The bottom clamp jaw moves vertically. Both clamp jaws have a butyl rubber facing to form a good seal against the mine body.

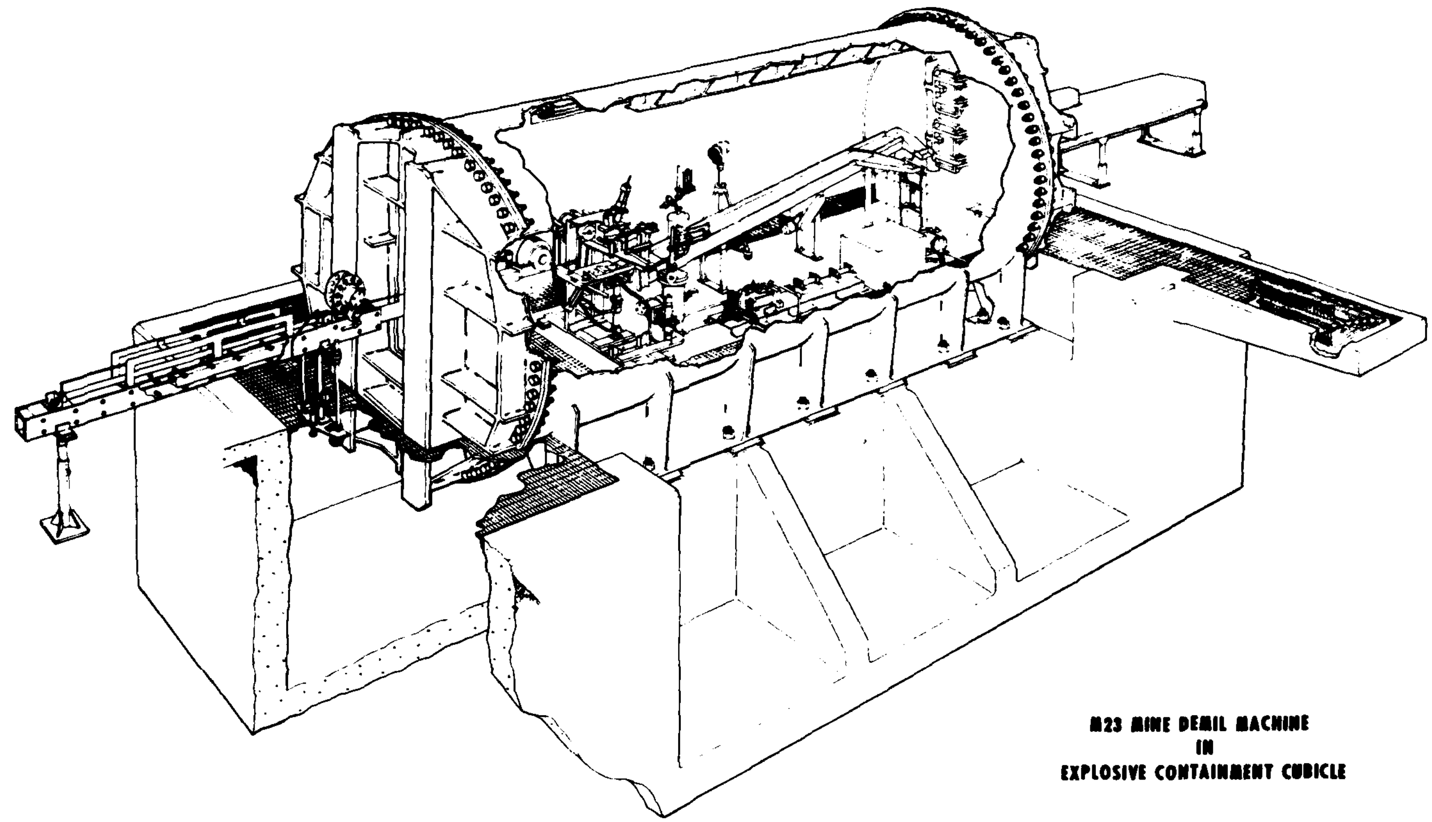
(3) Hydraulic punches (Figure 4-20). A hydraulic punch cylinder is attached directly to each clamp jaw. The clamp jaws are drilled and serve as guides for the punch rods. Seals are installed in the clamp jaws around the punch rods.

(4) Agent drain system (Figure 4-21). The agent drain system is connected to a port drilled through the bottom mine clamp jaw. The system consists of a separation tank containing a demister, a surge tank, a vacuum pump, a diaphragm type agent pump, level sensors and solenoid valves.

(5) Booster retainer ring remover. This device is installed on a vertical moveable carriage. It consists of an expandable collet that is extended and retracted with one cylinder and expanded with a second cylinder moving a cone shaped core inside the collet jaws.

(6) Booster removal device. This device is similar to and works on the same principle as the delta P projectile burster remover described in Section 4-6, paragraph b(6). It is mounted on the same carriage as the booster retainer ring removal device.

(7) Adapter plate removal head (Figure 4-20). This device is used to remove the adapter plate from the bottom of the mine so the main explosive charge can be removed. It consists of a cylindrical floating head rotated by a hydraulic motor. A hydraulic cylinder extends and retracts the head. A cone shaped pin in the center face of the head



M23 MINE DEMIL MACHINE
IN
EXPLOSIVE CONTAINMENT CUBICLE

Figure 4-18

APRIL 1973

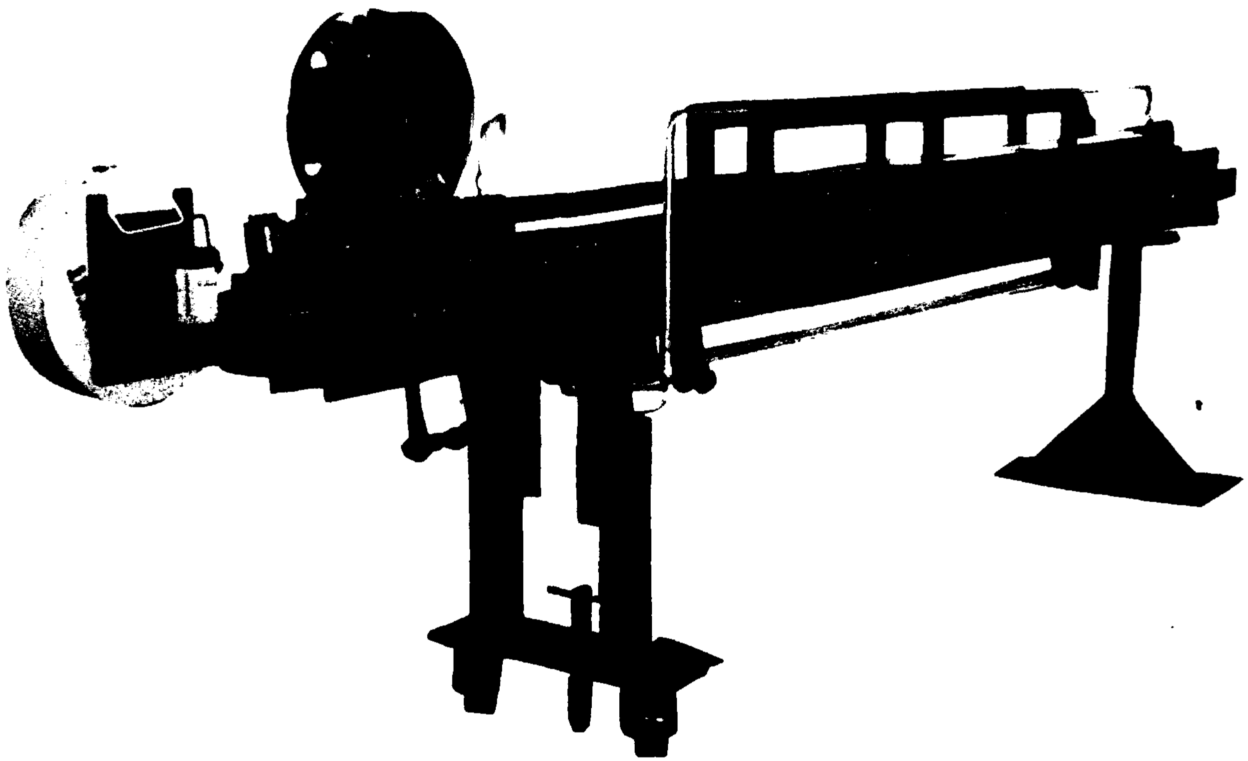


FIGURE 4-19 ECC MINE INPUT CONVEYOR

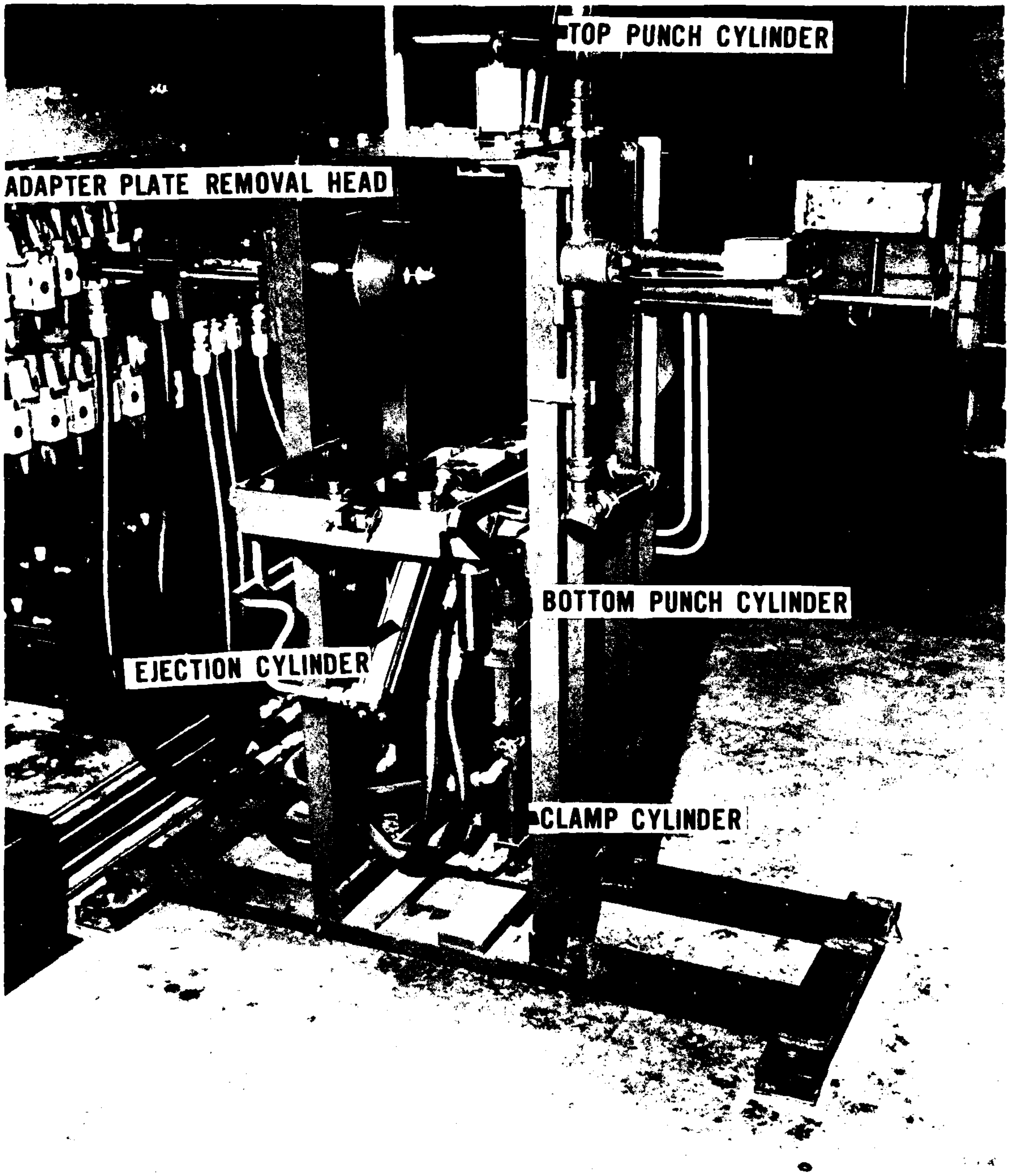


FIGURE 4-20 **MINE DEMIL MACHINE**

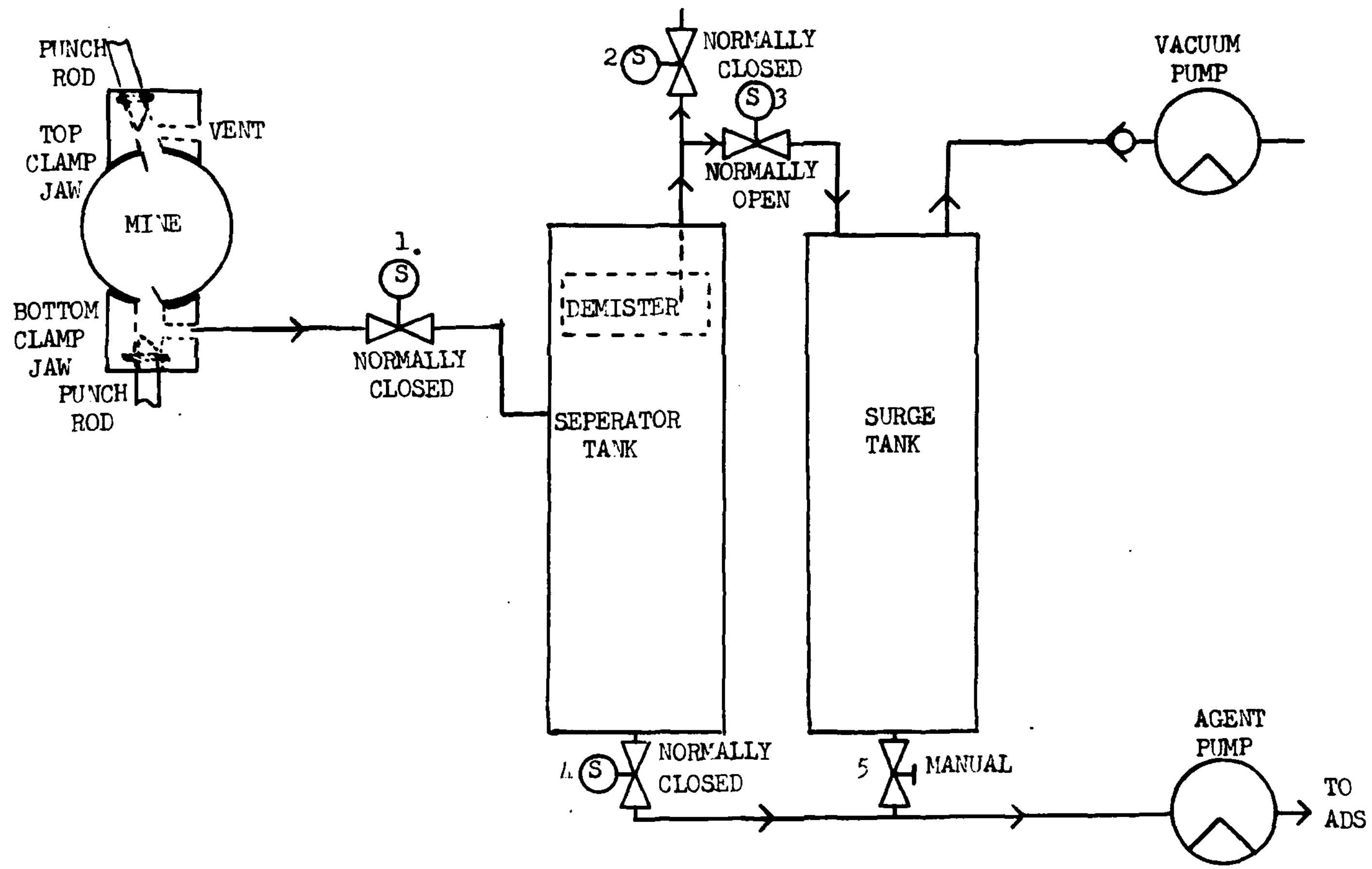


FIGURE 4-21 MINE AGENT DRAIN SYSTEM

centers the head with the adapter plate. Two drive pins in the face of the head enter spanner wrench holes in the adapter plate to turn the adapter plate.

(8) Output conveyor. This conveyor is located outside of the ECC in line with the ECC item-out door. It is a multitray moveable bed conveyor actuated by a hydraulic cylinder. Hydraulic cylinders mounted on the frame of the conveyor are used to dump the trays one at a time.

(9) Discharge conveyor. This conveyor is an electric motor driven belt conveyor located along side the output conveyor. It transfers the mine parts from the output conveyor to the input conveyor for the Deactivation Furnace.

c. Operation.

(1) Input conveyor. The Unpack Area operator, after removing the arming plug and fuze spring (Figure 4-22), places the mine on the ECC input conveyor and signals the computer to start operations. The ECC input door opens and the conveyor extends into the ECC. The conveyor, when fully extended, has the mine properly positioned between the clamp jaws in the Mine Demil Machine.

(2) Hydraulic clamping device. The bottom clamp jaw raises lifting the mine out of the cradle on the input conveyor and clamping it firmly against the top clamp jaw. The ECC input conveyor retracts to its original position ready to receive the next mine. The ECC item-in and vent doors close.

(3) Hydraulic punches. Both punch cylinders extend full stroke, then retract, punching a vent hole in the top of the mine and a drain hole in the bottom of the mine.

(4) Agent drain system (Figure 4-21). Before the mine is punched, a vacuum pump draws the separator tank and surge tank to approximately 10.4 psi below atmospheric pressure. After the mine is punched, solenoid valve 1 opens and the mine drains into the separator tank. The demister prevents VX droplets from entering the vacuum system. When all the agent has drained, vent air through the mine rapidly increases the pressure in the separator tank. When the pressure reaches 7.4 psi below atmospheric, a pressure switch closes valves 1 and 3 and opens valves 2 and 4. The agent is pumped from the separator tank to the Agent Destruction System (ADS). When the separator tank is empty, a level sensor closes valves 1 and 4, opens valve 3 and signals the computer to initiate the next operations. After the mine is drained, it will be rinsed with either a decon solution or water. The necessity and efficiency of a decon rinse will be assessed during the initial test phase of this program. The rinse solution will be pumped to a decon hold tank in the ECC housing where sufficient hypochlorite decon will be added to assure destruction

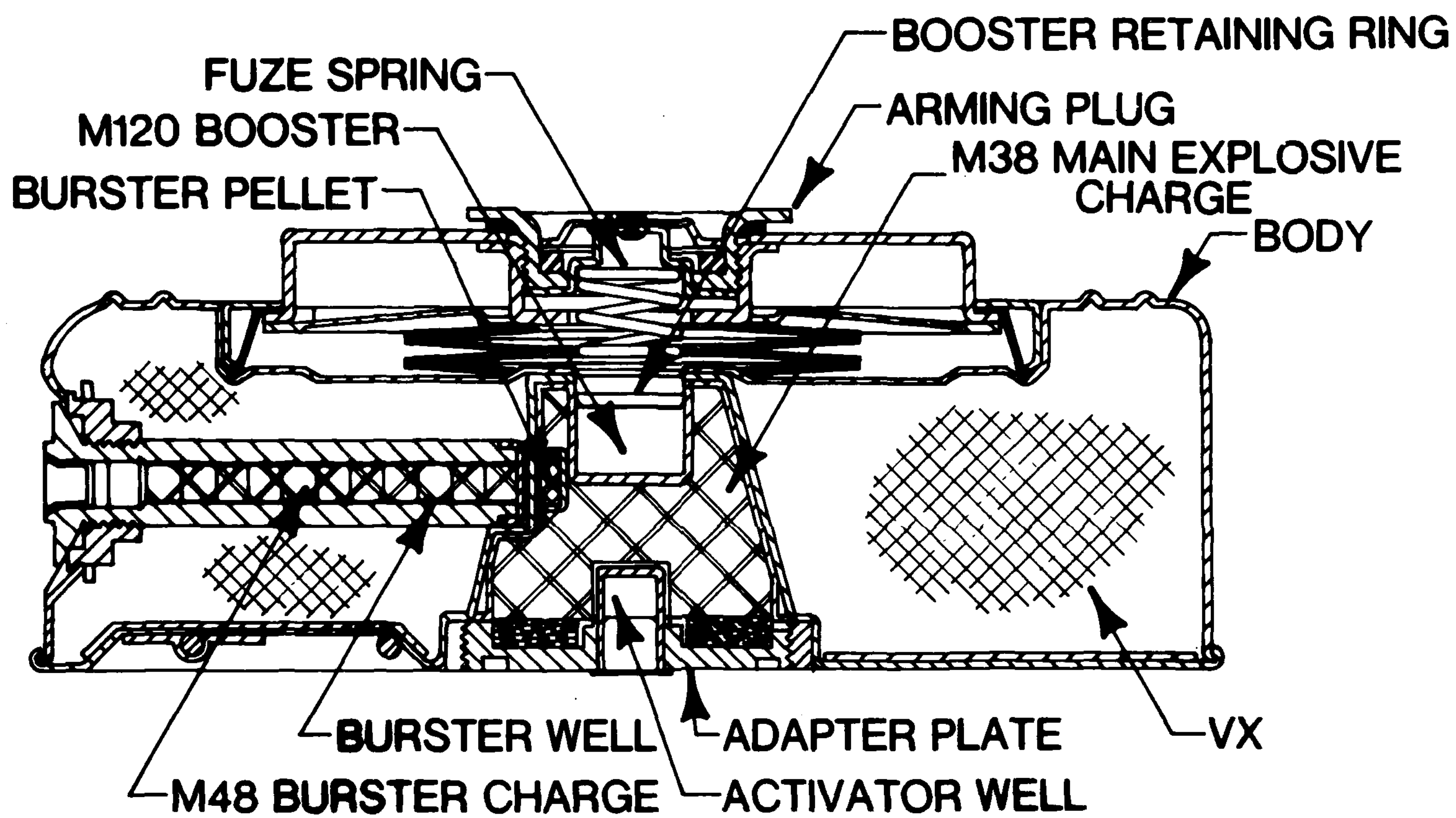


FIGURE 4-22
MINE, CHEMICAL AGENT, PERSISTENT, VX, 2-GALLON, M23

of residual agent as measured by enzymatic analysis. After certification, the solution will be pumped to the ADS waste neutralization tank for pH adjustment prior to drying on the ADS drum dryers.

(5) Booster retainer ring removal device. A hydraulic cylinder moves the carriage supporting the removal device in line with the mine booster. The collet extends through the mine fuze well until it is inside the retaining ring and against the booster. The collet expander cylinder retracts to expand the collet jaws inside the retainer ring. The collet retracts out of the mine pulling the retainer ring with it. The collet expander cylinder extends releasing the retainer ring. The ring drops into a chute and slides into a catch tray.

(6) Booster removal device. The moveable carriage shifts again until the booster removal device is in line with the mine booster. The removal device extends until the delta P head is sealed against the mine body. The booster pull tube extends in through the mine fuze well until it is against the mine booster. Air pressure is then applied to the delta P head and the booster pull tube retracts pulling the booster completely out of the mine body and into the delta P head. The air supply is turned off and the delta P head retracts on the booster pull tube, which causes the booster to be pushed out of the delta P head. The booster falls into the same chute and tray as the retainer ring.

(7) Adapter plate removal. A hydraulic cylinder extends the removal head against the mine adapter plate. The hydraulic motor starts and the drive pins on the removal head engage the spanner wrench holes in the adapter plate. The removal head floats back against springs as the adapter plate screws out of the mine. The motor turns off and the removal head retracts. The adapter plate drops into a chute and slides into a catch tray.

The delta P pull tube is extended completely through the mine to push out the main charge. The pull tube retracts as the main charge drops into the same chute and catch tray as the adapter plate.

(8) Output conveyor. The ECC vent door opens and the ECC ventilation system pulls a negative pressure in the ECC. The ECC item-out door opens and the output conveyor extends into the ECC and mates with the Mine Demil Machine. The trays on the Mine Demil Machine dump the booster and main explosive charge into trays on the output conveyor. The bottom clamp jaw on the machine lowers and an ejection cylinder pushes the mine off from the bottom clamp jaws. The mine body with the side burster still intact slides down a chute into another tray on the output conveyor. The chute tips the mine 90 degrees so it sits on its base on the output conveyor. This prevents any residual liquid from dripping out of the mine in subsequent conveying operations. The output conveyor retracts to its original position and the ECC item-out door closes.

(9) Discharge conveyor. The discharge conveyor runs continuously. Cylinders on the output conveyor frame dump the output conveyor trays one at a time onto the discharge conveyor at timed intervals that will not overload the Deactivation Furnace. The discharge conveyor transfers the mine parts onto the Deactivation Furnace input conveyor.

d. Safety. The initiating devices (fuzes and activators) are not installed in the mines so there are no disarming procedures involved. The disassembly procedures are primarily a reversal of the assembly procedures. No cutting, punching or shearing operations are performed on the explosive components.

The operations are computer controlled to eliminate operator error. The operations cannot begin if the mine is improperly loaded on the input conveyor. Agent drain operations cannot begin until all ECC doors are closed and locked. Explosive removal operations cannot begin until the drained agent has been pumped out of the ECC. The potential for spreading agent during transfer of the mine will be greatly reduced by rinsing the mine body and by conveying it in a horizontal position. Maintenance personnel will wear level A protective clothing when working on the Mine Demil Machine.

e. References. The following references are contained in Inclosure 11.

(1) Test Report CAMDS 25-1. "Detonation Test of M23 Land Mine Body Containing M-48 Burster in APE 1236 Deactivation Furnace", 17 Nov 1971, by Ammunition Equipment Office (AEO), Tooele Army Depot (TEAD). A test to assure detonation of the burster would not damage the furnace.

(2) Test Report CAMDS 25-2. "M23 Chemical Land Mine Drain Test", 27 Jun 1972, by AEO-TEAD. Tests to obtain design parameters for the punch and drain station on a Mine Demil Machine.

(3) Test Report CAMDS 25-3. "M23 Chemical Land Mine Punch Tests", 29 Jan 1972, by AEO-TEAD. A test of 18 punch head configurations to determine the best one for use on a Mine Demil Machine.

(4) Test Report CAMDS 25-4. "M23 Chemical Land Mine Punch and Drain Tests", 25 Jan 1974, by AEO-TEAD. Operational test of the pilot model Mine Demil Machine using inert simulant filled mines.

(5) Test Report CAMDS 25-5. "Removal of M38 Burster from M23 Chemical Land Mines", Mar 1974, by AEO-TEAD. Operational test of the pilot model Mine Demil Machine using live empty mines.

(6) Test Report CAMDS 25-6. "Removal of Booster Retaining Rings", 18 Oct 1974, by AEO-TEAD. A test to determine if a standard tool developed on another project could be used to remove the booster retaining ring from M23 mines with plastic cased boosters.

(7) Test Report CAMDS 25-7. "M120 Booster Pressure Test", 6 May 1975, by AEO-TEAD. A test to assure that M120 bursters are not pressure sensitive.

(8) Test Report CAMDS 25-8. "M120 Booster Retaining Ring Remover", 7 May 1975, by AEO-TEAD. A test to determine the hydraulic pressure requirements for the pilot model booster retaining ring remover designed for the Mine Demil Machine.

4-8 MORTAR DEMIL MACHINE (MOR)

a. Purpose. The Mortar Demil Machine will be used to unscrew the M8 fuze with M14 burster attached (Figure 4-23) from 4.2 inch mortar shells and then unscrew the fuze from the burster.

b. Description. The final design of the Mortar Demil Machine has not been completed, therefore, a detailed description of the machine cannot be presented at this time. A firm decision has been made to demil the mortar shell by unscrewing the fuze and burster from the shell and then unscrewing the fuze from the burster. The machine will be designed to process two shells at a time.

c. Operation. Processing of the mortar shells into and out of the ECC will follow the same general operational procedures as described for projectiles in Section 4-6. The Mortar Demil Machine will contain a clamping station to hold the mortar shell and a rotating defuzing head to clamp onto the fuze and unscrew it from the mortar shell. The defuzing head will be mounted on a moveable carriage to pull the fuze with burster attached away from the mortar shell to a location where the burster will be between two hydraulic clamp jaws. The burster clamp will close and the defuzing head will rotate again to unscrew the fuze from the burster.

d. Safety. The Mortar Demil Machine will be computer controlled to eliminate operator error. No disassembly operations will begin until the ECC doors have been closed and locked.

e. Reference. Letter, AMXTE-AEO, Tooele Army Depot, 27 March 1972, subject: "Defuzing and Deburstering of 4.2 Mortar". This letter reported the results of a test to determine the torque and revolutions required to remove M8 fuzes and separate the M14 burster from the fuze on 199 mortar shells. A maximum of 150 ft lbs torque and six revolutions was required to remove the fuze. A maximum of 110 ft lbs torque and 16 revolutions was required to remove the burster. The full report is contained in Inclosure 11.

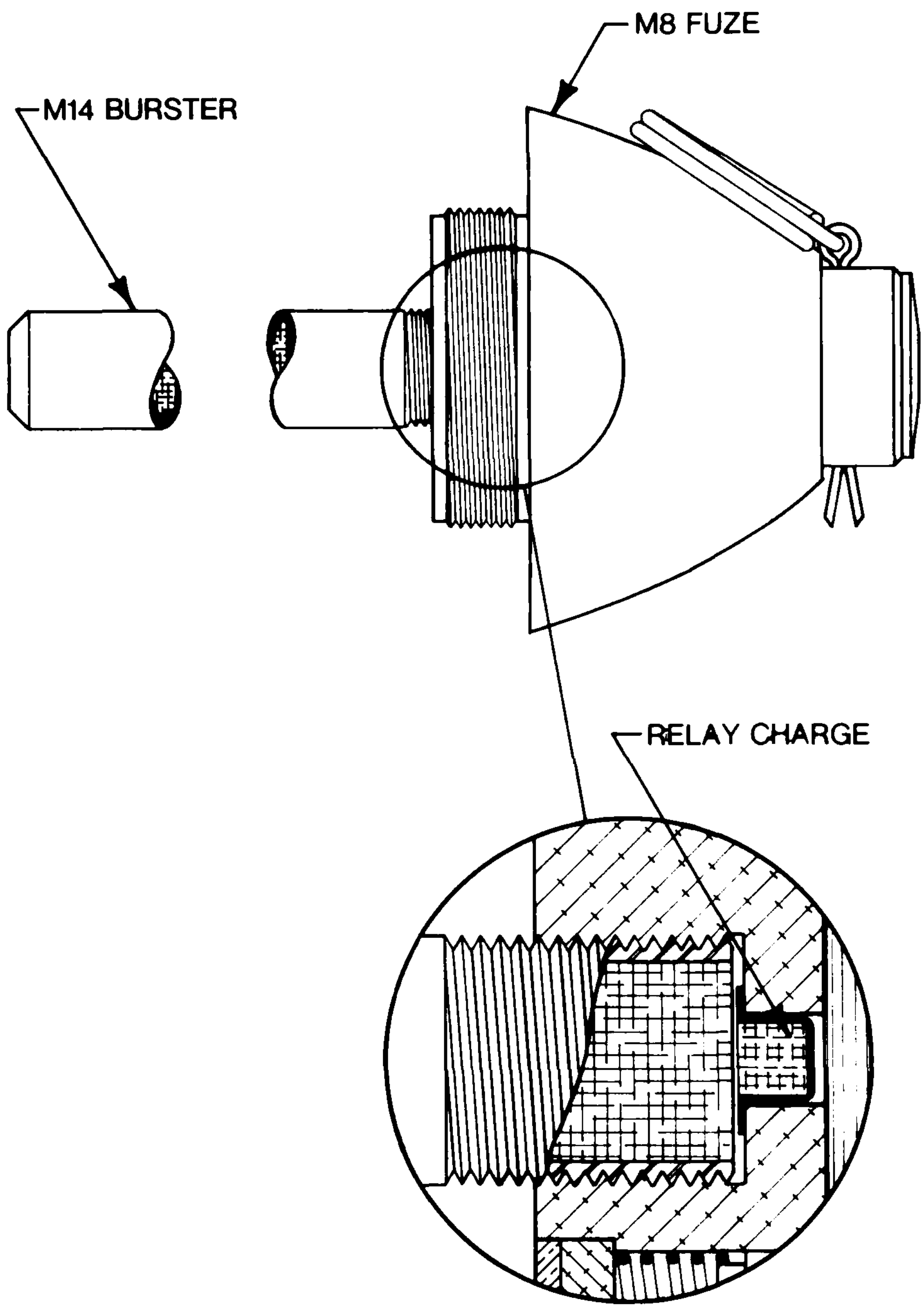


FIGURE 4-23 MORTAR SHELL FUZE AND BURSTER

4-9 ECC HYDRAULIC MODULE (EHM)

a. Purpose. The ECC hydraulic system supplies the hydraulic requirements for the Explosive Containment Cubicle (ECC), the equipment installed in the ECC and the ECC input and output conveyors.

A similar system is installed in the Projectile Disassembly Facility to supply hydraulic power for the Projectile Pull and Drain equipment and the Bulk Item Facility.

b. Description. The ECC hydraulic system is installed in a 10' X 27' portable housing adjacent to the ECC housing (Figure 4-24). The hydraulic fluid used in this system is a commercial water-glycol solution. The EHM housing is connected to the ECC ventilation system. It is designated as a six air change per hour area, i.e., normally uncontaminated.

The hydraulic system is a 20 GPM electric motor-driven pump mounted on a 100 gallon reservoir. It is equipped with a nitrogen-charged accumulator to assure a steady output at various load demand. It has a high pressure relief valve to guard against overpressure. It has suction and return line filters. It has thirty-two 10 GPM and two 45 GPM manifold mounted directional control valves. All the control valves are solenoid controlled or operated, three position, normally closed, four-way valves. The pump unit has temperature, level and pressure sensors for remote computer monitoring of the system. The system has two pressure regulators. Each pressure regulator controls the pressure to four of the directional control valves. The return line to the pump reservoir is equipped with a normally closed two-way solenoid valve and the pump output line has a one-way check valve to isolate the system from the ECC in case of an explosive incident in the ECC. The hydraulic lines pass from the EHM into a pit beneath the PDF input conveyor housing and underground to the ECC pit area. The EHM pit will be entered for maintenance on the hydraulic lines.

c. Operation. The ECC hydraulic system is computer controlled and monitored. After the equipment has been installed in the ECC to demil a particular type of munition, the only changes required to the hydraulic system are the presetting of pressure regulators and the selection of the proper computer program.

The water-glycol hydraulic fluid will be sampled once a month to assure the proper mixture of components. The solution will also be analyzed for agent on a periodic basis. Contaminated fluid will be withdrawn. Hydraulic fluid obtained from spills, leaks or draining of lines will be placed in low melt containers suitable for burning in the Metal Parts Furnace (MPF). Distinctive markings will be provided for the contain r holding waste fluid. The container will be stored in either the Bulk Item Facility or Metal Parts Furnace areas which are ventilated at 25 air changes per hour, pending disposal. When

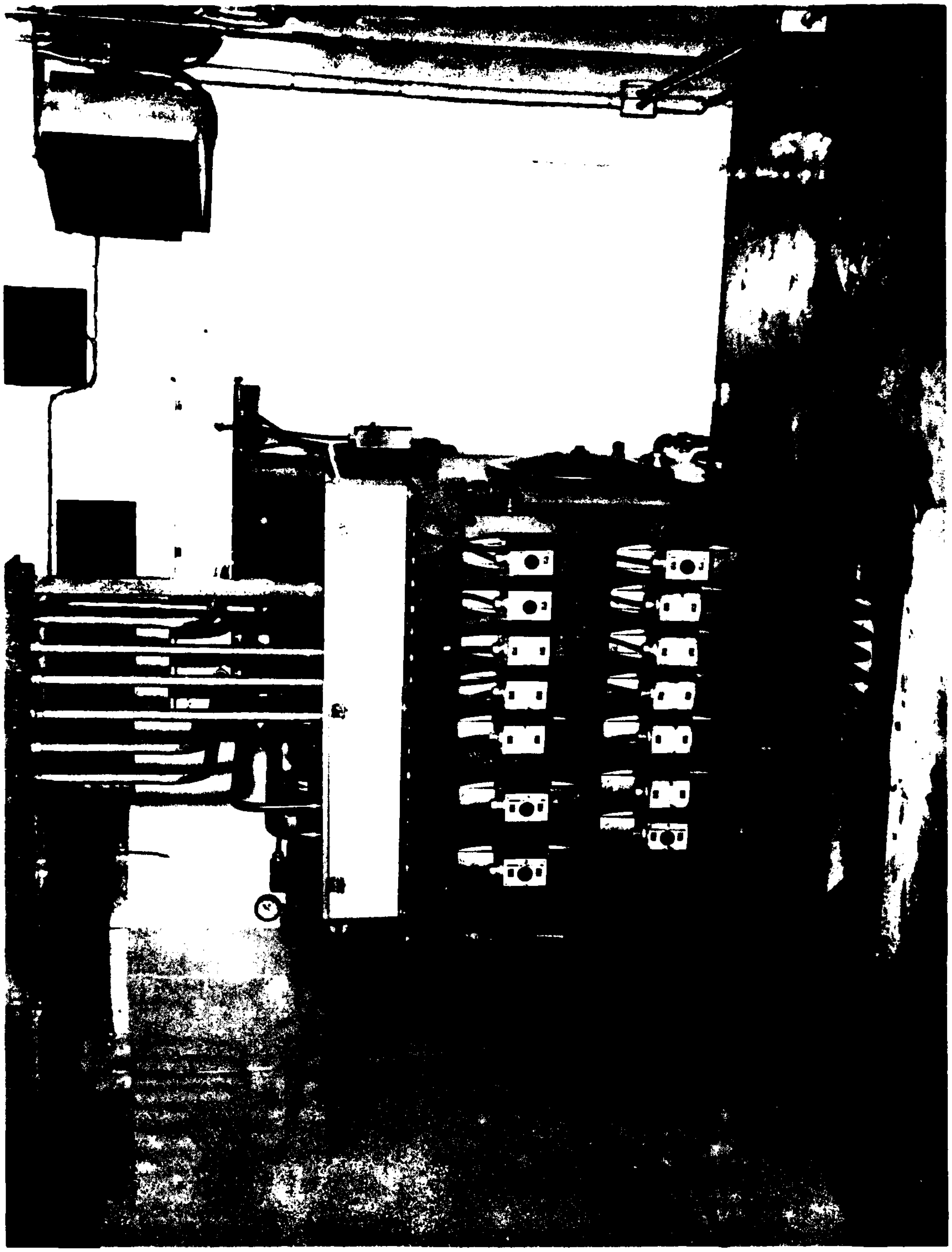


FIGURE 4-24 ECC HYDRAULIC PUMP

a sufficient quantity is collected, the container is sealed in a plastic bag and transported to the MPF by means of a fork lift truck. The hydraulic fluid container is placed in a cut up ton container or other suitable container for processing in the MPF. A maximum of 500 gallons of contaminated hydraulic fluid will be stored at one time. Containers of hydraulic fluid will not be transported during inclement weather.

d. Safety. The use of three position computer controlled normally closed directional control valves assures the equipment hydraulic lines will not be pressurized when personnel are performing maintenance in the ECC. They also assure excessive hydraulic fluid will not be dumped in the ECC.

Quick action isolation valves in the pump supply and return lines assure massive contamination cannot flow from the ECC to the pump reservoir in case of an explosive incident in the ECC.

The ECC hydraulic housing is maintained under negative air pressure by a filtered ventilation system to assure any low level contamination, which may develop in the hydraulic fluid returned to the reservoir, cannot escape to the atmosphere. Level C clothing will be used by personnel who enter the EHM on a routine basis. In the event agent is detected in the hydraulic fluid, level A protective clothing will be used. The use of water-glycol fluids in place of hydrocarbon fluids will permit the use of butyl rubber protective clothing.

4-10 DEACTIVATION FURNACE SYSTEM (DFS)

a. Purpose. The Deactivation Furnace System is used for the thermal deactivation of propellants and explosives for all chemical munitions. Furthermore, it will accomplish thermal detoxification of the metal parts containing residual agent from drained M55 GB and VX rockets and M23 VX mines.

b. Description The major components of the DFS are an oil fired rotary retort, a shrouded electrically heated discharge conveyor and an air pollution control system. The physical arrangement of the system is shown in Figure 4-25. The air pollution control system is designed to clean the flue gases of particulate and chemical pollutants to meet all Federal, State and local source air quality standards.

The flue gases from the retort are ducted through the air pollution control system which is comprised of: a cyclone collector, a slagging afterburner, a quench tower, a variable throat venturi scrubber, a packed bed scrubber with a demister section, an induced draft fan and a stack. Auxiliary equipment includes spent brine tanks with recirculating pumps, caustic supply tank, flame scanners and other process monitors and alarms. The motive power for the gas flow is the induced draft fan which is connected to an exhaust stack.

The double tipping valve, retort, and discharge conveyors are enclosed within a concrete barrier. The slagging afterburner, the air pollution control equipment, and the effluent gas monitoring station are housed within a prefabricated metal enclosure.

(1) Rotary retort. The heart of the system is the 30 foot long rotary retort having a single thread internal spiral of 2.5 foot lead providing a minimum of 12 minutes residence time at 1 rpm. An oil fired burner heats the retort and is monitored by an ultraviolet scanner for flame failure.

(2) Double tipping valve. This unit is an air cylinder sequenced arrangement of two flap valves in series located between the charge conveyor and the retort. The valves are interlocked to prevent simultaneous opening of both valves. Explosive and combustible materials are gravity fed through the double tipping valve which is designed to prevent the travel of any backblast to the feed conveyor in the event of an accidental high order detonation within the furnace. After each operating shift, the double tipping valve will be cleaned to remove any accumulation of propellant or explosive particles.

(3) Discharge conveyor. The discharge end of the retort is equipped with a vertical drop chute having a wide divergence angle to minimize discharge chute hangups. The material discharged from the drop chute falls onto a mesh alloy steel belt conveyor equipped with flights and located in a pit below the furnace level. This conveyor

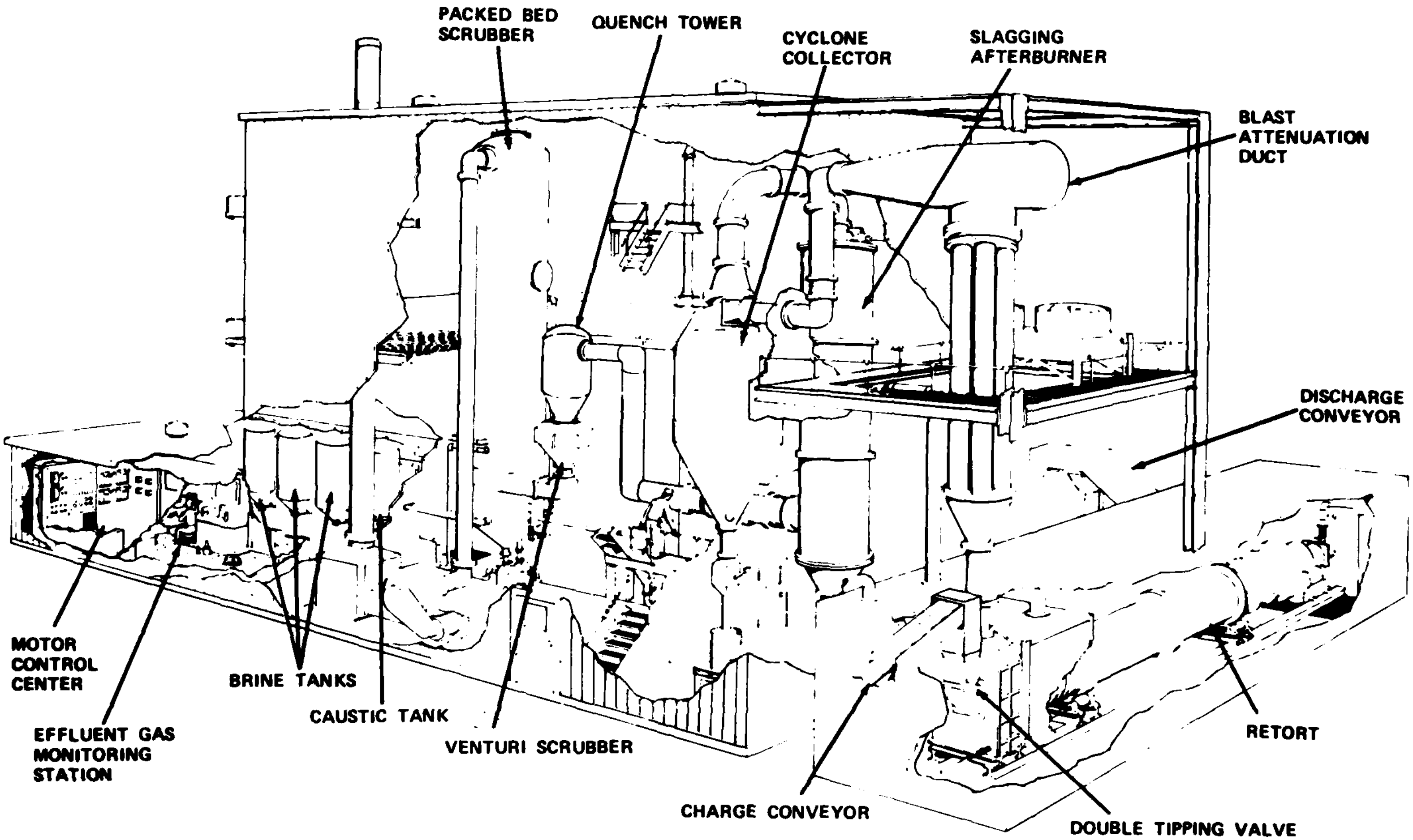


FIGURE 4-25 CAMDS DEACTIVATION FURNACE SYSTEM

is essentially a hot belt furnace and is housed in an electrically heated and insulated enclosure to provide sufficient holding time at temperature (1000°F) to ensure detoxification of any residual agent. The belt conveyor drops the discharged material through a trickle valve onto a scrap conveyor. The scrap conveyor, an articulated steel belt with flights, lifts the material out of the barrier pit into an enclosed container.

(4) Cyclone collector. The dry particulate collector is a vertical cylinder with the inlet stream introduced tangentially near the top. It has a conical bottom where the solids separated from the gas stream collect. There is a pipe extending down into the center of the cylinder through which the effluent gases exit the cyclone. A airlock valve is located at the narrow end of the conical bottom for periodic operations to empty the cyclone of collected solids. A clean-out port and an inspection window are provided on the wall of the dry particulate collector.

(5) Slagging afterburner. The required operating temperature/residence time in the afterburner will be such as to insure complete destruction of agent traces. Since the gas stream entering the afterburner could contain fibrous glass particles a slagging design is necessary. The afterburner is vertically oriented with the duct from the dry cyclone collector entering at the top of the afterburner. The burner system for the afterburner is a proprietary "hot track" design consisting of a recess in the refractory wall of a circular chamber with burners located so as to fire into the recess tangentially. The swirling combustion gases spread uniformly over the downstream refractory wall and produce a uniformly heated chamber wall. A downstream constriction mixes the furnace flue gases containing particulates with the swirling afterburner combustion gases.

(6) Quench tower. The quench tower is of a proprietary design that assures saturation of the flue gases before entering the venturi scrubber. This is essential to avoid loss in particulate scrubbing efficiency due to vaporization within the venturi as static pressure is reduced in the throat section. The quench tower is mounted on top of the venturi for co-current operation.

(7) Venturi scrubber. Saturated flue gas from the quench tower flows into the top of the venturi scrubber. Large, cyclonic-inlet scrubbing liquor ports without restricting nozzles are used in an enlarged diameter section to prevent plugging.

The venturi scrubber is provided with a variable area throat to maintain a constant pressure differential and high collection efficiency

over a wide range of flue gas flow. Throat area modulation is achieved by using an electrical plug nozzle insert positioner actuated by the differential pressure controller. The throat section is flanged for ease of removal and provided with a side access port for internal throat inspection.

(8) Packed bed scrubber. Flue gases from the bottom outlet of the venturi scrubber enter the packed bed scrubber tower through a baffled tangential inlet to minimize entrainment of the particulate laden liquid. A sump is located below the gas inlet.

A tilted chimney tray with bypass wash and bypass purge is installed above the gas inlet and is designed to minimize the particulate level in the clean liquor. Above the chimney tray a packed tower section operates at 70% of flooding velocity and is designed to give at least 95% SO_2 removal.

Clean liquor from the chimney tray is pumped to a weir trough distributor above the packed section of the tower. The packed section is followed by a demister section.

(9) Caustic tank. The caustic tank provides an interface supply between the main caustic supply source and the scrubber system. The tank is sized for approximately 8 hours hold-up of 18% by weight sodium hydroxide at 125% of the normal flue gas flow rate. The tank is equipped with a level control and an automatic blocking valve on the inlet.

(10) Brine tanks. Brine tanks are provided to permit isolation and sampling of the salt solution. The brine is checked for 5% excess sodium hydroxide/carbonate before pumping it to the dryer area of the Agent Destruction System. Each tank is sized for 4 hours hold-up at 125% production rate with allowance for salt dilution to 20% by weight.

The recirculating pump on the scrubbing tower sump outlet line connects to the brine tank inlet header through a flow control valve actuated by the sump level control. The brine tank outlet pump is equipped with a recirculating line fitted with a pressure control valve to provide thorough tank mixing to inhibit settling. Internal steam coils are provided to maintain the salt solution above its saturation temperature.

c. Operation. Segmented rocket parts, mine metal parts and all explosive components of the munitions are received from the Explosive Containment Cubicle (ECC) through an enclosed conveyor. The combustible or explosive items are gravity fed through the double tipping valve to the rotary retort. After approximately 12 minutes the incinerated scrap falls from the retort onto an electrically heated discharge conveyor providing an additional 30 to 60 minutes of residence time at detoxification temperatures of 1000°F. The certification and disposal of the metal scrap is outlined in Section 6. The flue gases leaving the furnace are ducted through a cyclone collector which removes large particles, especially fiberglass, from the rocket parts, and through an oil fired slagging afterburner which collects the finer fiberglass particles and destroys toxic vapors. The gases are then cooled by direct contact brine sprays in the quench tower, passed into a variable throat venturi scrubber, a packed bed scrubber and demister to remove the remaining traces of particulate and chemical by-products from the effluent gas stream. Brine is continuously removed from the scrubber bottom and transferred to brine retention tanks and then is pumped to the Agent Destruction System (ADS) for drying. Brine is checked for 5% excess sodium carbonate/hydroxide before it is sent over the ADS for drying.

d. Safety. The Deactivation Furnace input conveyor contains a belt with sides to assure that explosive dust and particles are retained on the conveyor. The double tipping valve, the retort and the discharge conveyor are enclosed within a 15 inch thick reinforced concrete barrier to prevent any fragements from hitting personnel or equipment should a catastrophic blast occur. The duct work out of the barrier contains internal baffling for blast attenuation.

The basic furnace design includes a double tipping valve to isolate the incoming components and shrouded conveyor from potential blast pressures within the barrier and to isolate the toxic environment of the input conveyor from the barrier enclosure around the retort. A light emitting diode photo cell system is incorporated into the feed chute of the retort to detect any jamming. The retort is fabricated from alloy steel having high strength at the operating temperature with sufficient wall thickness to prevent a catastrophic failure. A detonation in the retort would produce localized spalling which would be retained by the 15 inch thick reinforced barrier.

The air pollution control system is designed so that effluent gases meet all source air standards. The temperature of the gaseous stream after passing through the quench and venturi is monitored. In the event temperatures exceed 190°F, an alarm is triggered and water from an emergency head tank is automatically fed to the quench tower. The stack is monitored for agent and SO_2. The burners of the retort and the slagging afterburner are monitored for flame failure.

The slagging afterburner and the cyclone are isolated from the remainder of the enclosure to maintain negative pressure in this area. The air from this area and the air within the barrier are discharged through a charcoal filter of the Filter System.

Emergency power supplied by the CAMDS Electrical Distribution System is available to assure operation of critical equipment in the event of a power failure to provide for safe and orderly shutdown.

e. References.

(1) Report by Surface Combustion Division, Midland-Ross Corp., Toledo, Ohio, "Design Analysis, Deactivation Furnace Barrier for the CAMDS Project", Sep 74. Calculation of blast effects of "worst case" detonation, i.e., burster from 8" projectile, within the furnace.

(2) Allegany Ballistics Laboratory, Cumberland, MD Report, "Failure Mode and Hazard Effects Analysis of a Deactivation Furnace and Air Pollution Control System", 2 Dec 74. Failure mode and hazard effect analysis of toxic leak, explosion, equipment failure and operator error.

(3) Allegany Ballistics Laboratory, Cumberland, MD Report, "Human Factor Engineering Analysis of a Deactivation Furnace and Air Pollution Control System", 2 Dec 74. Recommended design and operating criteria to minimize system failure.

(4) Report by Alan A. Osgood, "Test Report for BB #3 CAMDS Deactivation Furnace Tests", Test No. CAMDS 03-1, 10 Dec 74. Sectional M61 rockets were successfully incinerated in a pilot retort at a rate of 40 units per hour. Particulates in the effluent gas stream were characterized.

(5) Report by Alan A. Osgood, "Thermal Destruction of M23 Landmines", Test No. CAMDS 03-2, 18 Dec 74. The M23 landmines were successfully deactivated in a pilot retort at a rate of 40 mines per hour. Burster detonations were originally experienced. This was corrected by the separation of the M120 booster from the M38 burster. See Incl 6.

(6) Report by Alan A. Osgood and Charles D. Stokeld, "CAMDS Deactivation Furnace Cyclone Scrubber Tests", Test No. CAMDS 03-3, 21 Nov 74. Repetition of CAMDS 03-1 tests after the inclusion of a cyclone collector to improve the efficiency of the pilot air pollution control system in removing large particulate matter from the effluent gas stream.

(7) Report by Alan A. Osgood, "Thermal Detoxification of M55 Rockets", Test No. CAMDS 03-5, 14 Apr 75. Detoxification of aluminum and fiberglass reinforced plastic parts from the M55 rocket at 1000°F for 15 minutes as tested by enzyme titration. See Incl 6.

(8) Report by Alan A. Osgood and Charles D. Stokeld, "Thermal Deactivation of Explosive Components of Chemical Munitions". Test No. CAMDS 03-6A, 20 Mar 75. Test verified that the uncut tetryl loaded burster of the 4.2" mortar could be thermally deactivated in a spiral retort. See Incl 6.

(9) Report by Alan A. Osgood, "Thermal Deactivation of Explosive Components of Chemical Munitions", Test No. CAMDS 03-6B, 17 Jun 75. Test verified that M557 fuzes, M40A1 bursters, M71 & M5 bursters could be thermally deactivated at a rate of 30 and 40/hour and M38 bursters at 24/hour in a spiral retort.

(10) Report by Jay K. Shah, Surface Combustion Division, Midland-Ross Corp., Toledo, Ohio, "CAMDS Deactivation Furnace Cyclone/Scrubber Test", 18 Feb 75. Contractor's evaluation of CAMDS tests 03-1 and 03-3, and recommended safety features. See Incl 6.

(11) Report by Jay K. Shah, Surface Combustion Division, Midland-Ross Corp., Toledo, Ohio, "Retort Blast Strength Calculation for Safe and Ultimate Charge Weights", 18 Mar 75. Design data for proposed furnace. See Incl 6.

(12) Report by James G. Conybear, Surface Combustion Division, Midland-Ross Corp., Toledo, Ohio, "Final Report for Bench Scale Corrosion Study", 30 May 75. Determination of corrosion rates of eleven alloys subjected to temperatures of 1300^{o}F and simulated atmospheres of VX plus calcium hypochlorite, GB, mustard, and VX plus lead acetate. See Incl 6.

(13) Report by Surface Combustion Div, Midland-Ross Corp., Toledo, Ohio, "Pilot Test for Slagging Afterburner", PX-1298, dated 25 Jun 75. Determination of fiberglass loadings in the gas stream during slagging afterburner tests.

4-11 METAL PARTS FURNACE (MPF)

a. Purpose. The purpose of the Metal Parts Furnace is to thermally destroy residual GB and VX agent contamination on munition components without explosives, and to thermally detoxify mustard filled ton containers and mustard filled munitions without explosives.

b. Description. The MPF processing system includes a direct fired three chamber roller hearth furnace, a primary fume burner, an auxiliary fume burner, a quench tower, a variable throat venturi scrubber, a packed bed scrubber with a demister section, burster well basket conveyor, a multi-position loader, bulk item loading station, scrap handling and cooling equipment (see Figure 4-26). The MPF air pollution system is designed to clean the flue gases of particulate and chemical pollutants to meet all Federal, State and local source air quality standards.

The roller hearth furnace, the fume burners, the charge car, the basket conveyor, and the multi-position loader are housed within a ventilated shroud. The shroud as well as the remainder of the equipment are housed within a prefabricated steel enclosure.

(1) Roller hearth furnace. The furnace is made up of three chambers: an uninsulated punching chamber, a refractory lined heating chamber for controlled volatilization of agent, and a second refractory lined heating chamber for final burnout of agent. The furnace chambers are separated by vertical lift inner doors. The work pieces are supported on alloy trays equipped with suitable fixtures. The trays are conveyed through the furnace by power driven rollers.

The heating chambers of the furnace are provided with air atomizing oil burners arranged to give direct flame impingement on the side of the bulk containers (ton containers and spray tanks). In the volatilization chamber, steam is used to give tempered flame operation, minimize development of hot spots on the container walls, and assure an oxygen deficient atmosphere during processing of mustard items. The burners operate at a slightly rich, controlled air/fuel ratio to prevent introduction of oxygen into the chamber. The excess water vapor introduced by the steam is removed in the quench/scrubber. Auxiliary controlled air/fuel ratio burners are provided above and below the work level for heating tray loads of projectiles. Flue gases from the volatilization chamber flow to the primary and auxiliary fume burner. Flue gases from the punch and burnout chamber are ducted to the auxiliary fume burner for final afterburning at a temperature/residence time adequate to destroy any residual agent (see Fig 4-27).

(2) Primary fume burner (PFB). Agent fumes from the punching chamber and the volatilization chamber are incinerated in an oil fired, horizontal, fume incinerator. The burners for the fume incinerator are of a proprietary "hot track" design used as an ignition source,

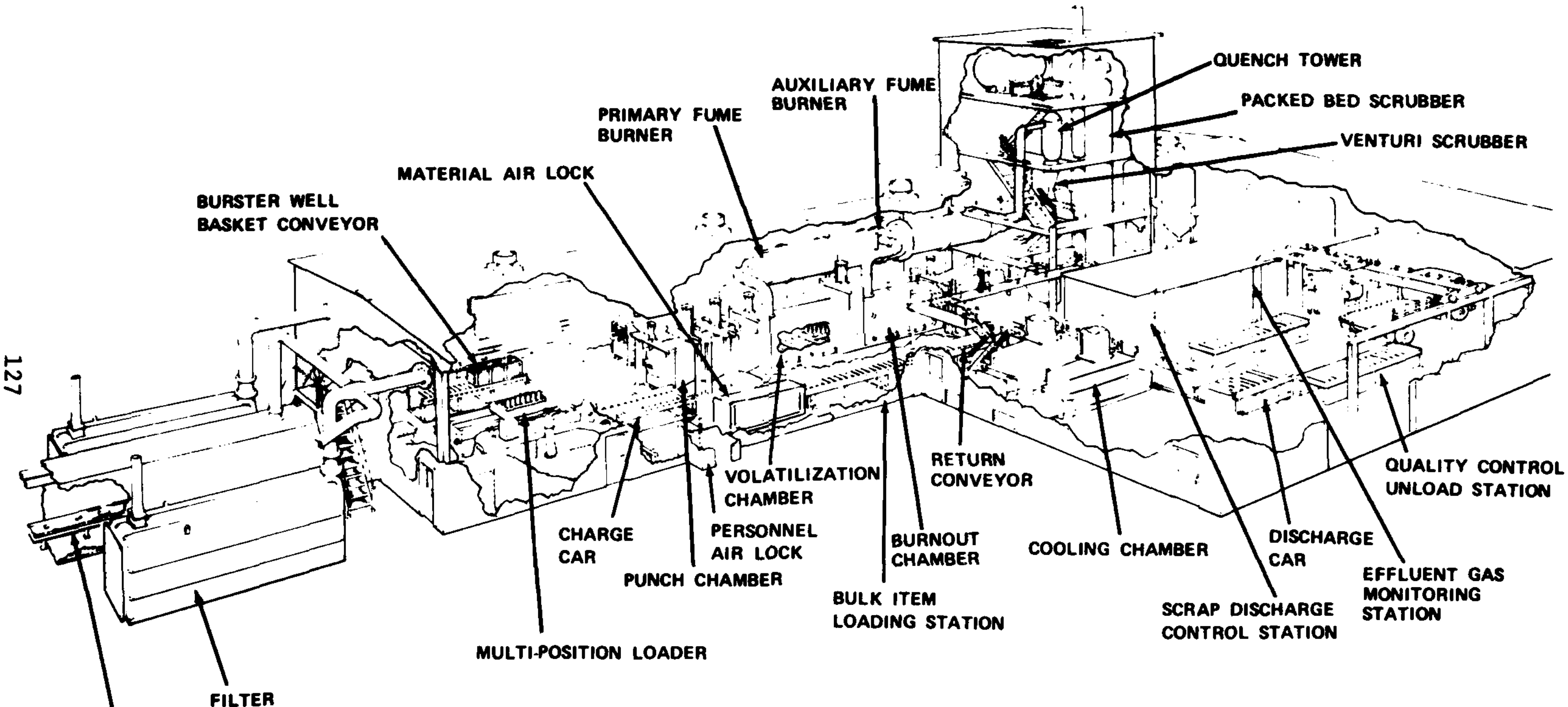


FIGURE 4-26 CAMDS METAL PARTS FURNACE SYSTEM

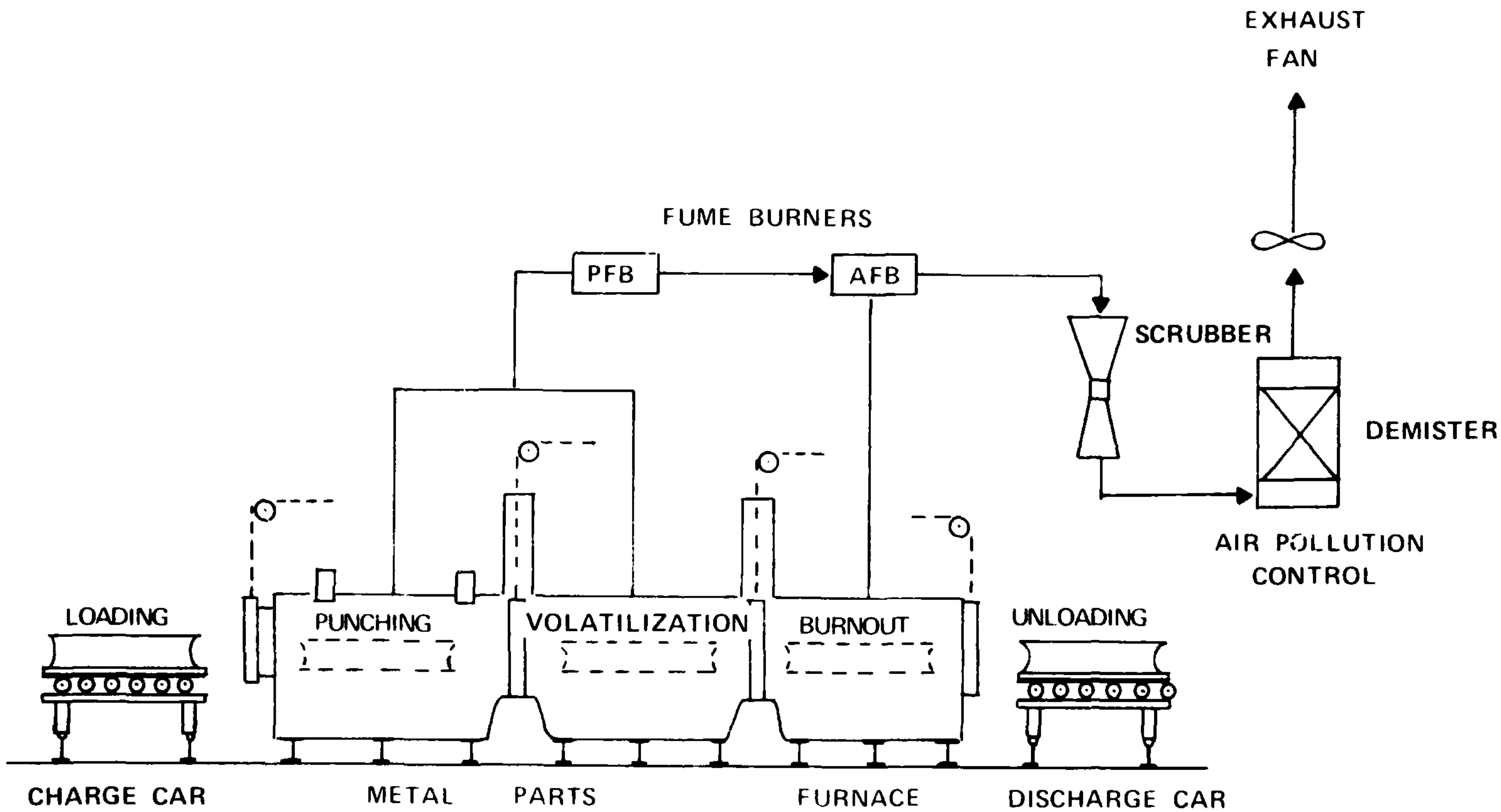


FIGURE 4-27 METAL PARTS FURNACE CHAMBERS & FUME BURNERS

and as a means to mix the auxiliary air with the fuel rich fumes prior to ignition. This is followed by a refractory lined residence chamber operating with a flue gas temperature/residence time adequate to destroy any residual agent. Two spark ignited oil burners are provided to ensure ignition and stable combustion of the rich fumes. The combustion air for fume burning is automatically controlled to pace the input of fumes from the furnace and maintain the residence chamber in the operating temperature range. The residence chamber thermocouple signal also regulates the burner input and dilution steam rate to the volatilization chamber so as to maintain the rate of volatilization in the correct range.

(3) Auxiliary fume burner (AFB). Fumes from the burnout chamber and the flue gases from the PFB pass through the AFB. This burner operates with a flue gas temperature/residence time adequate to destroy any residual agent. The AFB is provided with a spark ignited oil-fired burner identical to those used on the PFB. The PFB combustion air blower also supplies combustion air to the AFB.

(4) Multi-position loader. The multi-positon loader is located at the end of the Projectile Disassembly Facility output conveyor. It is capable of loading projectiles into an "egg-crate" fixture on a tray. The projectile filled trays are transferred into the furnace using the charge car.

(5) Bulk item loading station. This station includes a fork lift truck with boom and sling, a bulk item tray, tray return conveyor with airlock, remote control panel and TV camera/monitor to observe remotely controlled conveyor transfer sequences through the conveyor airlock.

(6) Burster well basket conveyor. Burster wells removed from projectiles are loaded into containerized (basket) trays using the same basic tray modules as the projectiles and the bulk containers. The basket-tray combinations are transported into the furnace with the charge car.

(7) Quench tower. The quench tower is of a proprietary design that assures saturation of the flue gases before entering the venturi scrubber. This is essential to avoid loss in particulate scrubbing efficiency due to vaporization within the venturi as static pressure is reduced in the throat section. The quench tower is mounted on top of the venturi for co-current operation.

(8) Venturi scrubber. Saturated flue gas from the quench tower flows into the top of the venturi scrubber. The venturi scrubber is provided with a variable area throat so as to maintain a constant pressure differential and high collection efficiency over a wide range of flue gas flow. Throat area modulation is achieved by using an electrical plug nozzle insert positioner actuated by the differential pressure controller. The throat section is flanged for ease of removal and provided with a side access port for internal throat inspection.

(9) Packed bed scrubber. Flue gases enter the scrubber tower through a 90 degree elbow followed by a baffled tangential inlet to minimize entrainment of the particulate laden liquid. A sump is located below the gas inlet.

A tilted chimney tray with bypass wash and bypass purge is installed above the gas inlet and is designed to minimize the particulate level in the clean liquor. Above the chimney tray is a packed tower section which is designed to give at least 90% SO_2 removal.

Clean liquor from the chimney tray is pumped to a weir trough distributor above the packed section of the tower. The packed section is followed by a demister section.

A removable plate is provided in the demister support sheet to allow bypassing the demister at higher gas flow rates when phosphoric acid mist will not be present. A crinkled wire mesh screen is provided for entrainment removal when the bypass is open.

(10) Scrap handling and cooling equipment. A hooded station is provided at the exit of the burnout chamber. Agent sampling at the exit of the burnout chamber will be included in the systemization test program. If residual contamination remains on an item which has been discharged from the furnace, the item will be moved back into the furnace and reprocessed immediately. MPF personnel will mask to perform this operation. Systemization testing will establish acceptable operating parameters to insure material exiting the MPF is decontaminated. Two air cooling chambers are located within the enclosure and adjacent to the furnace discharge car traverse track for cooling the scrap metal parts. The scrap metal parts are removed from the hooded station and transferred to one of the cooling chambers. The transfer car is remotely controlled for maximum operator safety. Each cooling chamber has sheet metal ductwork to direct fresh air in from outside the enclosure. Exhaust air is ducted through the enclosure to exhaust vents located external to the enclosure. The cooling chambers are completely enclosed with a steel shroud to direct the cooling air flow. Each chamber has a remotely operated vertical rising door to minimize entrainment of air from within the enclosure.

Scrap from bulk item processing is conveyed on trays using the discharge car to shuttle the trays to an off-loading roller conveyor located in the receiving and unloading area. This area is serviced by a rail crane and hoist. Transfer of the bulk items from trays to waiting empty truck is accomplished by manipulation of the rail crane and hoist controls. The hoist is equipped with an electromagnet arrangement, designed to adapt to the various bulk items and projectiles. The electric hoist has remote controls for manual operation of the equipment. The operator loads the scrap metal directly into waiting trucks.

c. Operations.

(1) Charge car. The loaded trays are transported from the tray loading stations to the furnace by the charge car. The car motion is remotely controlled from the control panel. Bulk items enter the furnace

loading area via the tray return roller conveyor. A fork lift truck with boom attachment is used to move the GB and VX drained bulk items from the Bulk Item Facility holding area to the roller conveyor. Mustard filled ton containers are transferred directly from the transport truck to the roller conveyor with the same fork lift/boom combination.

The bulk items are placed on the tray located on the roller conveyor immediately adjacent to the conveyor airlock outer door. Upon placement of the bulk item onto the tray, the outer door is opened and the tray/bulk item is transferred into the conveyor airlock, the outer door is closed, the inner door opened and the tray/bulk item is transferred onto the charge car. The roller conveyor airlock isolates the "clean" side of the conveyor from the "contaminated" furnace loading area.

(2) Furnace conveyor. Each furnace chamber is equipped with power driven, tray conveying rollers. The drives for each chamber can be operated independently. The furnace is provided with tightly fitting automatically actuated doors.

Positive positioning of the work trays is achieved by means of mechanical flag switches which stop the work trays in the exact position required for a particular process operation.

(3) Ton container punch chamber. The punching chamber is a ventilated uninsulated metal housing surrounding the ton container punching station. It is equipped with power-driven rollers to convey the loaded work trays to a fixed position beneath the punches determined by the tray tripping a flag switch located between conveying rollers. The entrance of the punching chamber contains a hydraulically actuated, vertical lift door which is electrically interlocked with the other furnace chamber doors. The punching chamber is vented by a duct leading to the secondary fume burner and is ventilated as required.

The purpose of the punch system is to provide openings at each end of the ton containers for release of agent vapors without internal pressure buildup during the volatilization period. The punch system consists of two hydraulically actuated punches passing through seals in the roof of the chamber. Anvils are correspondingly located beneath the support tray which elevate the tray above the conveyor rolls and provide support to the ton container during the punching operation.

When a limit switch indicates that the punching chamber outer door is in the raised position, the charge car and punching chamber roller drives are actuated to move a loaded tray to a station beneath the ton container punches. A flag switch automatically closes the punching chamber outer door. The operator then starts the punch sequence. The anvil rises and actuates a limit switch, the punching occurs, and limit switches are tripped to indicate that the punch completed its downward stroke and returned to its clear position.

Other bulk items and projectiles are handled without punching. The punching chamber serves only as a vestibule in this case.

(4) Volatilization and burnout chambers. The method of operation of these chambers is dependent on the item to be incinerated. The following describes the operation for filled mustard ton containers, filled mustard projectiles and agent drained munitions/bulk containers with respect to the volatilization chamber and burnout chamber. The operating temperature of the fume burners is identical regardless of the munition being processed.

(a) Mustard filled ton containers. The volatilization chamber is equipped with two sets of controlled air/fuel ratio burners, one consisting of conventional over and under-firing burners for control of chamber wall temperature during heat-up and a second set located opposite the centerline of ton containers for impingement heating during both the heat-up and controlled vaporization periods. At the start of the heating period the chamber wall temperature is maintained at about 900°F by a differential head controller. Midway through the heat-up period the controller drops the wall temperature approximately 600°F and maintains this temperature until the heat-up is completed (approximately 1 hour). A 100 degree temperature rise of the gas stream in the primary fume burner indicates that mustard vaporization has commenced and when this signal has been received the over and under-fired burners are automatically shut off and input for heat losses and mustard evaporation is provided by the controlled ratio, direct impingement burners. Further control is provided by dilution steam for rapid modulation of the chamber temperature and for oxygen level control.

The combustion air input to the primary fume burner will be controlled as required to maintain the operating temperature at the desired rate of mustard volatilization. The fuel input to the direct impingement burners is controlled automatically to maintain a constant flue gas temperature of adequate to destroy any residual agent.

The fuel input to the volatilization chamber is controlled to maintain a constant temperature in the primary fume burner when supplied with its rated combustion air. As the residual mustard agent in the ton container decreases, the temperature in the volatilization chamber increases to maintain the desired volatilization rate. The volatilization chamber temperature will reach its upper limit of approximately 900°F but the mustard volatilization rate will start to decrease as the residual mustard is consumed. At this point, the combustion air to the primary fume burner starts decreasing to maintain temperature. When the burner combustion air reaches it minimum flow rate, the volatilization is complete so an interlock is made, and the ton container is moved to the burnout chamber. The volatilization chamber will already be at approximately 900°F when the fresh ton container is charged.

The burnout chamber temperature and metal parts residence time is controlled to destroy any residual agent. When processing ton containers, bayonet type sparging air lances are lowered automatically to the punched openings. The sparging air completes the burnout of solid carbon or sulfur or gases trapped beneath scale pockets. Sparging will take place during the final 50% of the burnout cycle.

(b) Mustard filled projectiles. Detoxification of mustard filled projectiles represents the heaviest furnace loading both in heat load requirement and total amount of mustard evaporation on an hourly rate basis. Each tray load of 155mm projectiles contains 44 projectiles so that the cycle time will be 66 minutes. During the heat-up period both the over and under-fired controlled ratio burners and the controlled ratio impingement burners will be firing. Use of the impingement burners assists in spreading the period of mustard evaporation over a longer time because the outer row of projectiles and particularly those projectiles directly in the path of the combustion products will heat up more rapidly and start volatizing mustard before the projectiles in the center rows.

When a 100°F increase in the primary fume burner flue temperature indicates that volatilization has commenced, the burner input is controlled to maintain the flue temperature constant at 1600°F when the PFB is supplied with its rated combustion air.

As in the case of the filled ton containers, the controller decreases the volatilization chamber wall temperature to about 700°F just before the end of the heating period. Dilution steam is used for rapid modulation of the chamber temperature and for oxygen level control.

(c) Drained munitions and bulk containers. The only cases to be considered for this type operation will be the drained munitions and containers having less than 5% of the original GB or VX fill. All mustard agent munitions and containers will be processed in the filled state. The volatilization chamber wall temperature is maintained at a constant temperature for drained projectile and ton container loads. Only the over and under-fired controlled ratio burners will be required for the bulk containers. Vaporization of liquid GB and VX is completed in the volatilization chamber to insure that incineration takes place in both the primary and auxiliary fume burners. Any traces of agent in the metal components will be destroyed in the burnout chamber which is controlled to maintain the temperature/residence time of the metal parts to destroy any residual agent. The flue products from the burnout chamber are vented directly to the auxiliary fume burner.

(5) Flue gas control. Flue products from the fume burners are cooled by direct contact brine sprays in the quench tower. From the quench tower, the gases flow into a high energy venturi scrubber followed by a packed tower and a demister section. Motive power for the gas flow circuit is provided by an induced draft exhaust fan. Gases are vented through the stack equipped for continuous monitoring.

A caustic sodium hydroxide solution is used as the scrubbing liquid in the quench, the venturi and the packed tower. The spent caustic brine is pumped to a holding tank and then the brine is pumped to the Agent Destruction System for drying and disposal.

(6) Metal scrap removal. Detoxified scrap metal parts are removed from the furnace by the discharge car and transferred to the cooling chambers. The cooling air is exhausted outside to avoid over-heating the enclosure. After the scrap is cooled and certified it is loaded into trucks using a remotely operated crane and hoist (see Section 6). The trays are returned for reloading.

d. Safety. The furnace design includes safety features such as interlock systems to prevent premature or inappropriate opening of furnace doors or engaging of roller drives. A closed circuit TV monitors the multi-position loader operation and bulk item charging of the furnace. An airlock separates the bulk item loading and furnace charge car shroud. Ultraviolet sensors are used to detect flame failures. Remote controls are used for the operation of scrap unloading equipment at the discharge end of the furnace. A controller interlock exists between the afterburner and furnace burner system to flood the volatilization chamber with steam in the event of a high temperature excursion during mustard operations. The gas quench tower is provided with an emergency water deluge line which floods the tower in the event of an over temperature excursion. In addition there are stack monitors for agent and SO_2 and agent monitors are provided at critical work and process equipment areas in the enclosure. Emergency power is available to assure operation of critical equipment during a power failure to provide for a safe and orderly shutdown. The multiposition loader area and the MPF charge car area are designated as contaminated level A areas and are ventilated at a rate of 25 air changes per hour through charcoal filters. The adequacy of the ventilation system will be verified during pre-operational tests. Personnel working in the areas will wear level A protective clothing. Entrance and exit from these level A areas will be through a personnel airlock containing a fresh water personnel shower. Personnel decontamination procedures will be comparable to those described for the Unpack Area and ECC housing airlocks. To control the level of contamination in the multiposition loader area, spot ventilation will be provided around the open trays of projectiles. Sumps in these areas will collect liquid from floor drains. The sump contents will be pumped on demand to the waste neutralization tank in the Agent Destruction System for certification prior to drum drying.

e. References.

(1) CAMDS Test Summary, "HT Incineration Pilot Studies for Metal Parts Furnace," by Misiewicz and Roux, May 74. The destruction efficiency of mustard (HT) ranges from 99.94% to 99.992% in a laboratory glass incinerator. See Incl 7.

(2) CAMDS Test Summary, "Pilot Test Results (Heavy HD Ton Containers)", by Lawhorne, 1 May 74. Ton containers with up to 1800 pounds of HD mustard can be detoxified at a controlled rate.

(3) CAMDS Test Summary, "Pilot Test Results (Projectiles)", by Lawhorne, 4 Apr 74. The results of incineration of H and HD filled projectiles under different specified conditions.

(4) Surface Combustion Division, Midland-Ross Corp, final data evaluation report, under Contract DAAA15-74-C-0092 by F. Rinker, "Metal Parts Furnace Piloting", 3 Jun 74. Describes the capability of controlling the evaporation of mustard at a desired rate. See Incl 7.

(5) Memorandum for Record, "Source Emission Results for CAMDS Pilot Test Program, Rocky Mountain Arsenal, Denver, Colorado," by Spann and Schenker, 20 Mar 74. Provides source emission data during HD ton containers burn tests indicating satisfactory emission control. See Incl 7.

(6) Demil/Disposal Office memorandum report, SAREA-DM, "GB Ton Container Hardware and GB Spray Testing in Building 538 Furnaces", 7 Aug 74. Drained GB ton containers can be safely detoxified in a furnace. See Incl 7.

4-12 EXPLOSIVE TREATMENT SYSTEM (ETS)

a. Purpose. The Explosive Treatment System processes the liquid produced by the Rocket Demil Machine and the Projectile Demil Machine and provides agent decon solutions to the Explosive Containment Cubicle (ECC). The liquid treatment involves the adsorption of any dissolved explosive from the solution. The ETS also provides for the mixing, storing and supplying of sodium carbonate decon solution for GB operations in the ECC and stores calcium hypochlorite decon solution prepared in the Central Decon System for supply on demand to the ECC during VX and mustard operations.

b. Description. The ETS occupies a separate ventilated housing equipped with an air filtration system. The major components of the ETS are: a decon supply tank; a vacuum conveyor used to transfer carbonate powder from shipping bags to the supply tank; a surge tank; three activated charcoal adsorption columns; a hold tank and ancillary control and monitoring equipment. See Figure 4-28.

c. Operation.

(1) Fresh decon solution is pumped upon demand to the ECC from the ETS supply tank. The spent decon solution or water from the ECC is pumped into a surge tank in the ETS.

The solution is pumped from the surge tank through two activated charcoal adsorption columns in series to adsorb any dissolved explosive. an analytical test will be used to determine the explosive content of the solution. The standard is less than 0.5 ppm explosive. The third column is kept in standby to allow uninterrupted operation whenever one of the columns requires replacement of saturated packing. The operators will be required to switch adsorption columns and exchange fresh granulated charcoal for saturated material. They will also be responsible for the operation of process monitors and controllers.

The saturated charcoal is placed into a container and stored for eventual disposal by incineration. The treated liquid is stored in a hold tank until pumped to the the Agent Destruction System for disposal.

(2) During GB operations, the operators at the ETS prepare a 10% Na_2CO_3 decon solution from carbonate powder for use in the Explosive Containment Cubicle. One percent diammonium phosphate is added to the carbonate to inhibit generation of hydrogen when aluminum items are processed. The ETS has the capacity to provide at least 150 gal/hr of decon solution.

During VX and mustard operations the operators pump 10% calcium hypochlorite decon solution from the Central Decon System to the ETS decon supply tank for use in the ECC. This system has the capacity to provide at least 150 gal/hr of decon solution.

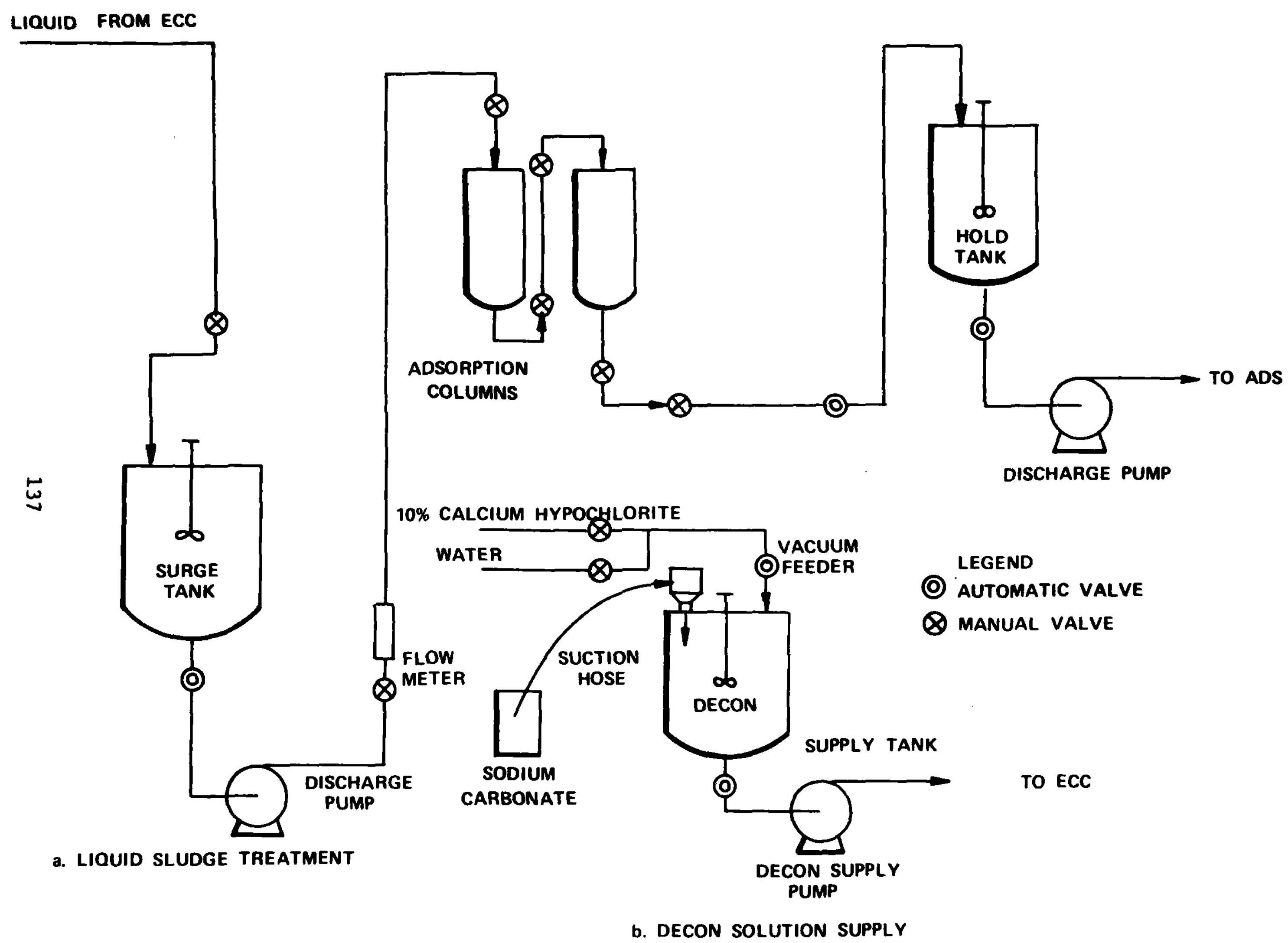


FIGURE 4-28 EXPLOSIVE TREATMENT SYSTEM SCHEMATIC

d. Safety. Operators will wear eye protection, rubber gloves and aprons for protection against chemical spills during decon preparation. The ETS enclosure is not considered a contaminated area, however, it will be ventilated at six changes per hour with exhaust passed through a charcoal filter system. An eye wash and a safety shower are available in the ETS area. A sump in this area will retain washdown solutions. The sump contents will be pumped to the waste neutralization tank in the Agent Destruction System (ADS) after every washdown operation for certification by use of 5% excess sodium hydroxide/carbonate prior to drying on the ADS drum dryers.

e. References.

(1) Picatinny Arsenal Propellants Research Branch Report No. 72-FR-G-R-66, "Investigation of GB and VX filled M55 Rocket Sludge" by Frank Pristera, Sep 1972. In terms of explosive hazard, the sludge from cuttings plus either sodium carbonate or calcium hypochlorite decontamination solution is safe to handle when it is wet. The charcoal from carbon filters in the test system had no brisance and no impact sensitivity. See Incl 9.

(2) Picatinny Arsenal Technical Report 4554, "A Laboratory Study of Carbon Adsorption for Elimination of Nitrobody Waste from Army Ammunition Plants" by Eskelund & Kuck K. Wu etal, Jan 1973. These studies showed that carbon adsorption was an effective method for removing nitrobodies from waste streams.

(3) US Army Environmental Hygiene Agency Study No. 24-033-73/74, "Carbon Column System Removal Efficiency Study", 2 May - 22 Jun 1973. Samples of waste water discharged from one of the loading lines at Iowa Army Ammunition Plant were characterized to evaluate a Carbon Column Treatment System for removal of TNT and RDX. Removal efficiencies for TNT, RDX, TOC, solids (total, total dissolved, suspended, and total volatile), COD, turbidity, and sulfates were determined. Average removals in the columns, for a life cycle of carbon, of 268,900 gallons of wastewater, was greater than 97.7% for TNT, 91.5 - 92.7% for TOC, and 62.2 - 64.8% for RDX. Removal of suspended solids in the filter averaged 67.7% and in the columns averaged 54.2 - 55.7%.

(4) Test Report No. CAMDS 14-1, "Explosive Treatment System - BB #14 Equipment Shakedown Test" by James H. Tate, 6 Mar 75. The ETS equipment was tested and found to be fully adequate in capacity and reliable in operation. The design criteria were met. See Incl 9.

4-13 PROJECTILE PULL AND DRAIN MACHINE (PPD)

a. Purpose. The function of the PPD is to remove the nose closure from non-burstered projectiles, pull the burster well, and remove VX and GB agent from projectiles (see Figure 4-29).

b. Description. The PPD is located along with the Central Decon System (CDS) in the Projectile Disassembly Facility (PDF). The PDF structure is located between the Metal Parts Furnace and the Explosive Treatment System (ETS) and consists of a 40' X 100' concrete slab entirely covered by a gabled roof which is supported by a rigid steel frame. An enclosed 40' X 40' area at the ETS end of the structure contains the CDS and PPD. The Bulk Item Facility, a separate enclosed area, is located under the PDF roof at the other end.

Because the PPD is in a toxic area, it is contained within an interior housing (shroud) ventilated at a minimum rate of 25 air changes per hour. An airlock with shower, also ventilated with 25 air changes per hour, is attached to the shroud to allow access to the toxic area. Ventilation air exhaust is filtered through activated charcoal beds to remove traces of toxic agents. The PPD consists of the following stations.

(1) PPD load station

(2) Nose closure removal station

(3) Burster well weld cutting station

(4) Burster well pull station

(5) Drain station

(6) PPD unload station

The PPD is equipped with a separate water-glycol hydraulic system similar to the one described in Section 4-9 but located in a small ventilated housing outside the PDF adjacent to the PPD input conveyor. Operation of this hydraulic system will be comparable to the ECC hydraulic module.

c. Operation. All projectiles received at the PPD will be free of explosive material. Non-burstered projectiles come directly from the Unpack Area (UPA) by way of the Explosive Containment Cubicle (ECC) bypass conveyor. Burstered projectiles will have all explosives removed in the ECC prior to being transferred to the PPD. Only one type of projectile will be processed through the PPD at a time.

Six projectiles will be in the PPD at a time, one in each station. All stations operate simultaneously on different projectiles located in that station. Because several different types of munitions will be

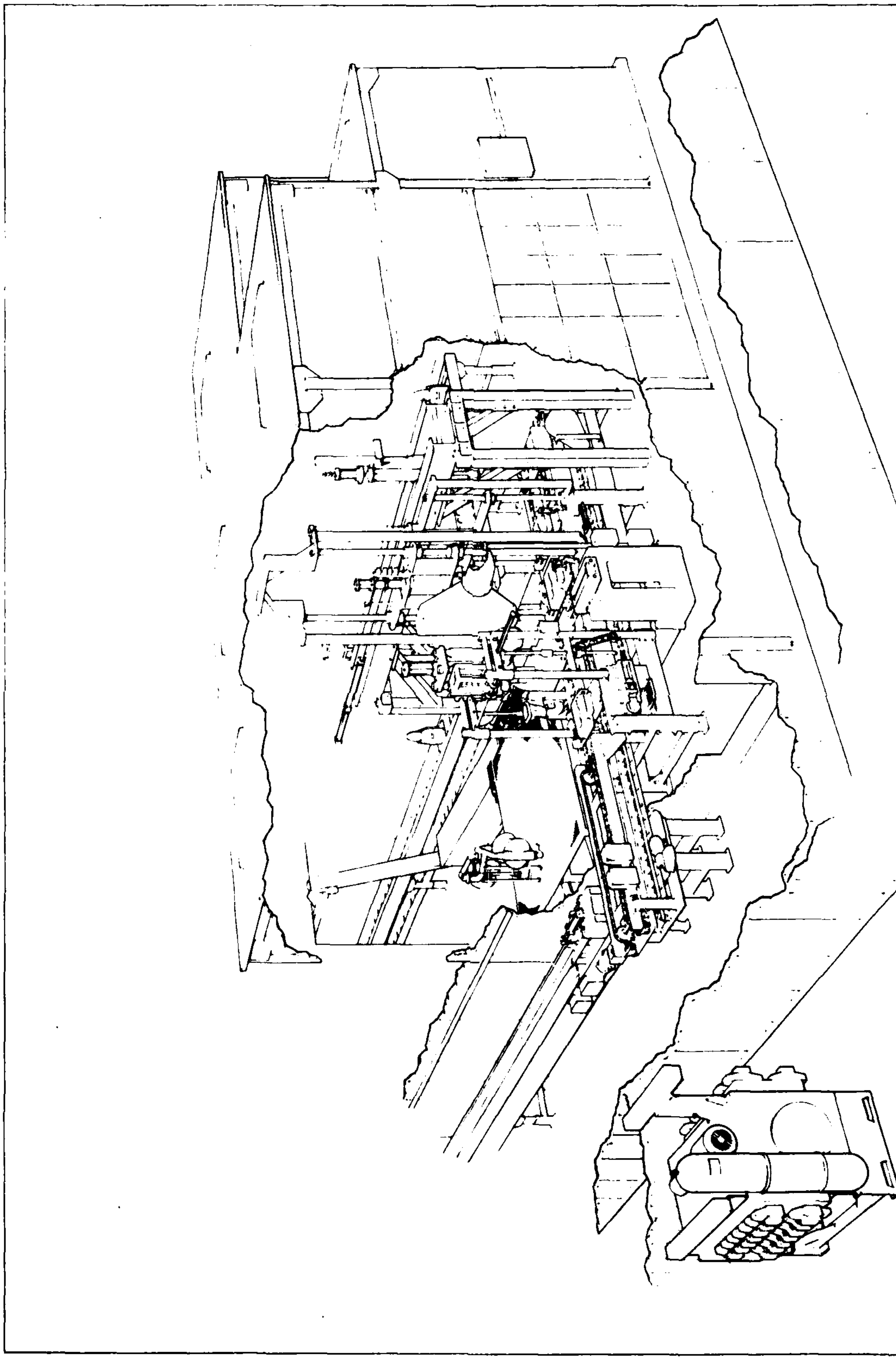


FIGURE 4-29 PROJECTILE PULL AND DRAIN MACHINE

processed in the PPD, every station will not be used on all munitions. The machine is capable of being adapted to the various munition types. A computer program has been developed to insure the proper sequence for each particular munition. Each station will be discussed according to the process sequence of munitions through the machine. All stations will be tied to a control program so that if a station fails to complete its operation, that operation will automatically be repeated before the conveyor can advance the projectile. Should a station still fail to complete its function, the process will be automatically stopped until the malfunction is corrected.

(1) PPD load station. Projectiles are received at the PPD by way of the PDF input conveyor and PPD accumulator. The 25 foot accumulator provides for in line storage of projectiles for 20 to 30 minutes of operation (see Table 4-2). This will provide a cushion in the projectile line that will allow minor problems in the PPD to be solved without interrupting operations in the Unpack Area (UPA) and the ECC. A visual signal is provided in the UPA when the accumulator becomes 3/4 full so UPA production can be adjusted. An automatic shutdown of projectile lines preceding the accumulator will occur if the accumulator becomes completely filled.

	Maximum Accumulation	
Projectile Type	Number	Operation Time
105mm	19	22.8 minutes
155mm	13	24.0 minutes
8-inch	10	30.0 minutes
4.2 inch	18	21.6 minutes

TABLE 4-2, PPD ACCUMULATOR DATA

When the load station is ready to accept a projectile, the accumulator allows the projectile to advance to the PPD load conveyor by way of the 90 degree turn machine. The turn machine is a turn-table which turns the projectile 90 degrees to facilitate entry into the PPD. Once the projectile is turned, a hydraulic, motor-driven ram pushes it into the load station. The projectile enters the load station in a horizontal position base end first. When the projectile mates with the PPD conveyor, a hydraulic piston causes a preset springloaded clamp to engage, thus securing the projectile in the conveyor. The projectile is now ready to advance. The conveyor advances the projectile, brings it into a vertical position and takes it to the next station.

(2) Nose closure removal station. The nose closure removal station uses a high torque, 3/4 inch drive, low rpm pneumatically-operated impact wrench. A clamp device consisting of three "arms", 120 degrees apart, grips and unscrews the nose closure. After the closure has been removed,

the cavity is probed to determine that a burster is not present. All projectiles entering the PPD, even those coming from the ECC where the burster was removed, are probed in this station. The process will not continue should a burster be detected.

(3) Burster well weld cutting station. This station will be used on projectiles that contain welded burster wells. They will not be processed with the other munitions. This station utilizes a 10 horsepower vertical boring mill with a hydraulically controlled feed rate and a variable speed from 100-600 rpm. To secure the projectile for the milling operation, a hydraulic clamp is used in addition to the previously applied spring clamp. The milling head is lowered and the weld is removed by the milling process. The milling head then raises, the hydraulic clamp is released, and the projectile is advanced to the next station.

(4) Burster well pull station. Guide pins are incorporated in this station to insure that the projectile is aligned with the pulling apparatus. This apparatus consists of a hydraulically operated carriage which is lowered to cause a collar to make contact with the tapered outside surface (ogive) of the projectile. With the collar in contact with the projectile, a rod with an expandable collet attached is lowered into the projectile burster well. The collet is expanded causing it to press against the inside wall of the burster well. The collet is then raised, removing the burster well from the projectile. The pulling power of the pull station is approximately 14.5 tons. If wells cannot be extracted with this force, the round will be removed and will be processed through the PPD at a later date. When these items are processed, the computer will be programmed to utilize the burster well weld station milling operation to cut away part of the burster well, reducing the force required to pull the well. After the well has been raised to a point where it is free from the projectile, the entire carriage is raised. A chute swings into position beneath the burster well and the well is released into the chute. The chute directs it onto a polypropylene-linked belt conveyor submerged in decon solution. The burster well is then conveyed to the Metal Parts Furnace (MPF). Chips from the milling process that have fallen into the burster well will be collected at the decon tank. After the burster well has been removed, the chute returns to its original position and the projectile is advanced to the next station.

(5) Drain station. Only GB and VX agent will be removed in this station. Projectiles containing mustard will be transferred to the MPF for incineration of the mustard in the projectile. GB and VX agent removal is accomplished using vacuum to drain the munition. A vacuum tube and probe are hydraulically lowered into the projectile. The probe is provided to determine when the agent has been removed. When the tube is in position, a diaphragm drain pump is turned on and agent is removed and transferred to the Agent Destruction System. Less than 1 percent residual agent will remain in the projectile. The vacuum tube and probe are then raised and the projectile is advanced to the next station.

(6) Unload station. Transfer of the projectile to the MPF is accomplished by a powered roller, floor level conveyor. To transfer the projectile onto the conveyor, a tapered collet will be used. The collet will be lowered into the projectile cavity and expanded tightly against the inside projectile wall. The spring clamp that has been used to hold the projectile throughout the PPD operation will be opened and the projectile will be lifted by the collet device and transferred to a cubicle holder on the PDF output conveyor.

The projectiles are conveyed to the MPF in a vertical position. The specially designed cubes are provided with a spill-over lip to minimize agent contamination of the conveyor. A side track on the PDF output conveyor will be used to allow "problem" projectiles (projectiles with burster wells that couldn't be pulled) to be automatically removed from the production line without shutting it down. A manually operated unload station will be provided so these projectiles can be removed from the side track conveyor.

d. Safety. The entire process is computer controlled and under normal operation, personnel will not enter the PPD housing. The computer will automatically stop the operation should any machine functions not perform. In the event of equipment malfunction, operators, wearing level A protective clothing, will enter the PPD housing through the airlock. Decon solution and water are located within the shroud to permit decon/washdown of any equipment within the shroud. Floor washings and shower drains will be collected in a sump within the PPD housing. Periodically, the sump contents will be pumped to the waste neutralization tanks in the ADS for pH adjustment and certification as agent-free prior to drum drying on the ADS equipment. Shroud windows are provided to permit visual contact between personnel within the PPD housing and the PDF. A water safety shower, separate decon hose and agent detector are located within airlock for operators leaving the PPD housing. Operator decontamination procedures will be identical to those employed in the Unpack Area and ECC housing airlocks.

The PPD will not process any explosives at anytime. This condition is assured by probing every projectile entering the PPD to determine that a burster is not present.

Although the PPD housing and associated conveyor housings are treated as level A contaminated areas, efforts will be made to minimize the level of contamination. Stations of the PPD where agent vapor release is probable will be provided with localized ventilation tied in with the PPD air filter. Where technically feasible, contaminated surfaces will be automatically rinsed with decon solution. A means of covering open projectiles during transport to the MPF is being investigated to reduce potential agent vapor release in the PDF conveyor tunnel. The utility of these precautions will be evaluated during initial pilot tests on this equipment.

e. References. Testing that has been accomplished to date, and PPD related data are contained in Inclosure 11. The Projectile Pull and Drain Machine (PPD) was at one time called the Pull, Drain and Rinse Machine (PDR) and these terms are used synoymously in Inclosure 11.

(1) Test Report CAMDS 18-1. "PDR Agent Drain and Decontamination Test", by Donald L. Walker and Arthur L. Genoble, May 1973. Tests provided data on the times required to perform various functions of the PPD and established reliability of the drain system.

(2) Test Report CAMDS 18-2. "PDR Agent Drain Test", by Joe Fitzgerald and Donald L. Walker, Jan 1974. A modified design using a diaphragm pump in lieu of tanks and associated hardware, provided a significant improvement for the drain and rinse station of the PDR.

(3) Test Report CAMDS 18-3. "Pull, Drain and Rinse (PRD) Simulant Drain Tests", by Joe Fitzgerald, May 1975. Results of these tests demonstrate that the present design of the agent drain station is more than adequate for satisfactory performance at extreme conditions (VX simulant at -10°F).

4-14 CENTRAL DECON SYSTEM (CDS)

a. Purpose. The CDS mixes, stores and supplies calcium hypochlorite decon solution to all areas of CAMDS for VX and mustard operations. The CDS also stores sodium hydroxide decon solution received from the Agent Destruction System (ADS) for supply on demand to the Projectile Pull and Drain Machine (PPD) and the Bulk Item Facility (BIF).

b. Description. The CDS occupies a chamber in the Projectile Disassembly Facility. The major components of the CDS are: a decon supply tank, a vacuum conveyor used to transfer hypochlorite powder from shipping drums to the supply tank; two holding tanks; and ancilliary control and monitoring equipment. See Figure 4-30.

c. Operation. During GB operations the CDS operators supply sodium hydroxide solution to the Bulk Item Facility and the Projectile Pull and Drain machine for processing GB munitions and/or bulk containers. The decon solution is pumped from the Agent Destruction System into a 1200-gallon working capacity tank. The solution is then pumped on demand to the user stations.

During VX and mustard operations the CDS operators supply 10% calcium hypochlorite solution to the BIF, the PPD, and the ETS. The operators prepare the decon solution from hypochlorite powder; store the solution in two 600-gallon tanks; and pump the solution on demand to user stations. The CDS has the capacity to provide 1200 gallons of solution per day in this configuration.

d. Safety. Operators will wear eye protection, rubber gloves and aprons for protection against chemical spills during decon preparation. An eye wash and a safety shower are available in the CDS area.

e. References. Test Report CAMDS 19-1, "Central Decon System - BB #19, Equipment Shakedown Test", by James H. Tate, 6 Mar 75. The CDS equipment was tested and found to be fully adequate in capacity and reliable in operation. The design criteria were met.

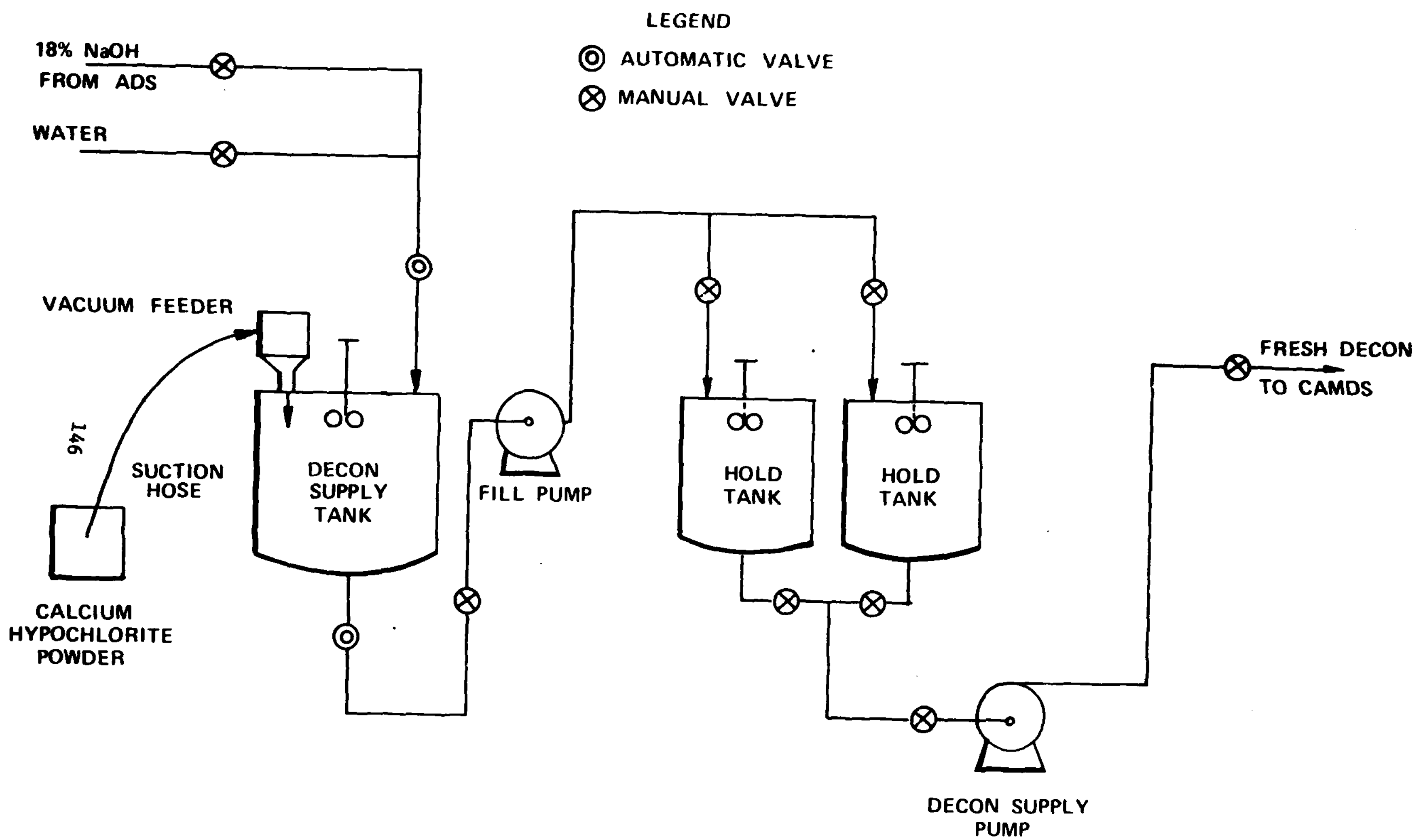


FIGURE 4-30 CENTRAL DECON SYSTEM SCHEMATIC

4-15 BULK ITEM FACILITY (BIF)

a. Purpose. The Bulk Item Facility is the area designated for drainage of large filled munitions and bulk storage containers. The following items, none of which contain explosive components, are to be handled in the BIF: MC-1 Bomb, GB, 750 lbs; TMU 28/B Spray Tank, VX; Ton Containers, GB and VX.

b. Description. The BIF is enclosed within a housing located within the Projectile Disassembly Facility. The BIF housing contains a toxic room with a drain area and tank/pump area, a control room, a buffer zone/airlock and a personnel decon room (see Figure 4-31). An enclosed holding area, also in the PDF housing, is located adjacent to the buffer zone/airlock portion of the housing. The drain area contains a drain fixture which incorporates pneumatic, hydraulic and mechanical features to support, move and weigh the bulk item during the process sequence. The tank/pump area contains plumbing equipment (pumps, piping valves, etc.) for agent and decon transfer as well as a decon solution supply tank and a sump tank. The control room serves as a monitoring and operating station for agent draining, decon and liquid transfer sequences and contains control and instrumentation equipment required for process operation. The control room also incorporates a glove port to provide manual manipulation access (i.e. plumbing connections, external decon rinse, etc.) to the bulk item/drain fixture during process operations. The buffer zone/airlock serves as an area to isolate personnel conducting operations in the toxic room from the holding area. The personnel decon room provides level A suit decon facilities for personnel conducting operations in the toxic room. The holding area serves as a combination storage, preparation and transfer area for items processed in the BIF. The BIF also incorporates an overhead monorail and associated material handling equipment.

c. Operation. The bulk items are transported by truck from the storage area to the west door of the holding area where they are inspected for possible agent leakage. At this point, the items are transferred by fork lift from the transport truck to the holding area through the west roll-up door. The number of bulk items kept at the holding area will be limited to no more than 5 ton containers, 3 spray tanks, or 24 bombs. Within the holding area the items are picked-up and conveyed by means of the overhead hoist through the buffer zone/airlock into the toxic room drain area and lowered onto a drain fixture. In the case of the ton container, plumbing connections are made to the valved end through the glove port. The agent is drained via a pump suction and pumped to the Agent Destruction System (ADS). The empty container is rinsed with decon solution and permitted to stand for a prescribed period of time. The decon solution is then pumped to the decon storage tank. The valves are closed, plumbing connections removed and these along with the entire valved end of the container externally rinsed with decon solution and water.

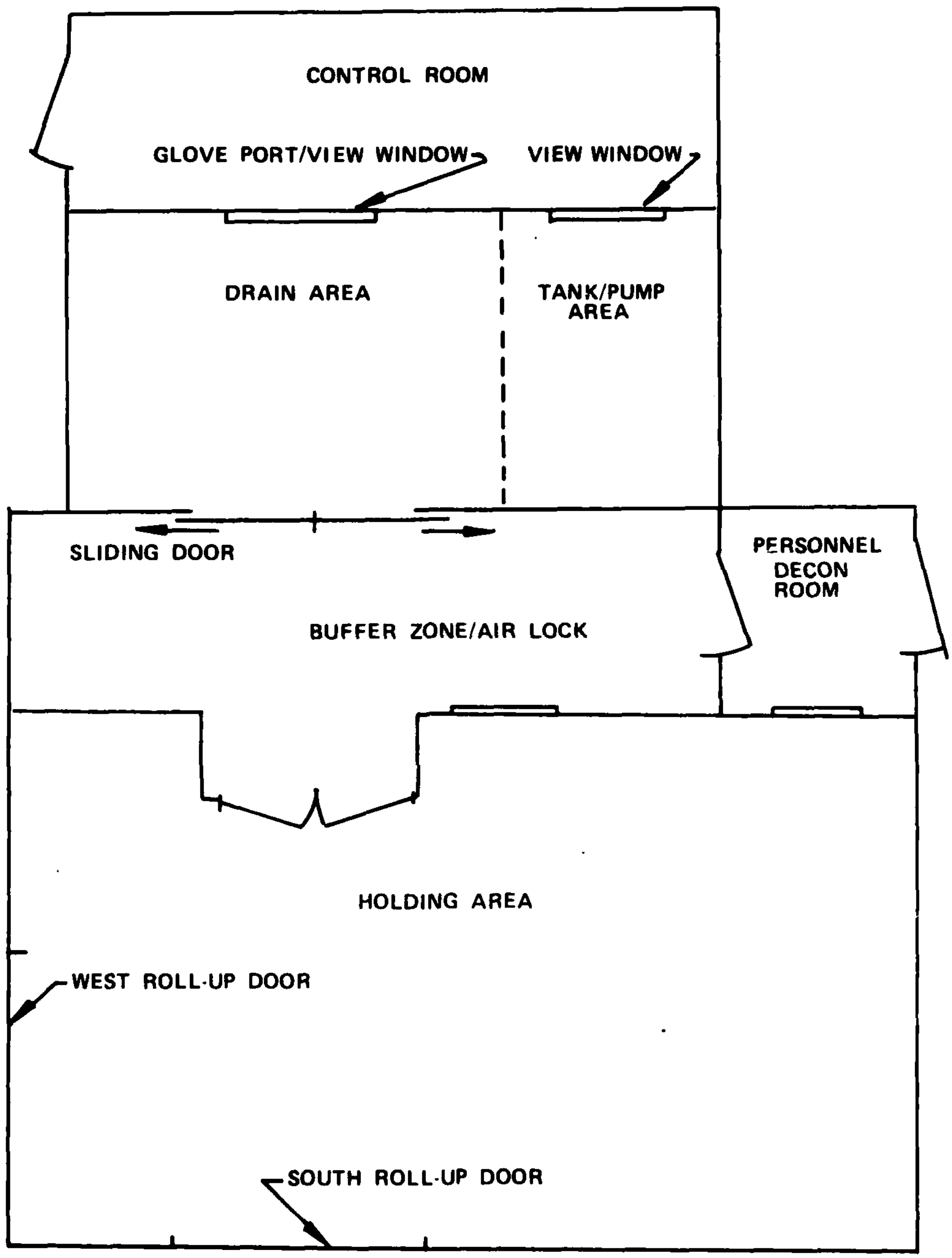


FIGURE 4-31 BULK ITEM FACILITY FLOOR PLAN

After completion of external decon rinse and verification that the container is free of external contamination, it is removed from the bay via the overhead hoist and conveyed to the south roll-up door of the holding area where it is transferred to a handling skid. At this point the container is picked-up by a fork lift truck/boom combination and transported to the Metal Parts Furnace where it is punched and detoxified.

In the case of the bombs and spray tanks a drain/vent hole is drilled through the item wall. An agent drain line is inserted in the hole and the agent is drained via a pump suction from the item and pumped directly to the ADS. The internal portion is then deconned in the same fashion as the ton container. After internal decon the drain/vent hole is plugged with a rubber stopper. The external portion around the drain/vent hole and the drill and plumbing equipment are flushed with decon and water. The item is verified to be free of external contamination and then removed from the bay and transferred to the Metal Parts Furnace in the same fashion as the ton container.

Decon solution, supplied by the Central Decon Supply (CDS), for internal flush is drawn from a 400 gallon tank (300 gal working capacity) located in the pump/tank area. When monitoring instrumentation indicates that this solution is spent it is pumped to the ADS for disposal. Fresh decon solution for external rinse is drawn directly from a reserve tank located in the CDS. Fluid from external decon rinse, emergency and personnel decon showers is piped via trapped floor drains into a catch tank in the pump bay. When this tank becomes filled to a predetermined level the fluid is pumped to the ADS for processing and disposal.

d. Safety. Personnel conducting operations in the holding area will wear level C or level D protective clothing. Personnel performing maintenance and transfer operations of bulk items in and out of the toxic room will wear level A protective clothing. During operations conducted within the toxic room, the operators will be in continuous visual and audio contact with the operators in the control room. An essential safety element of the BIF is the filter ventilation system. The system provides 25 air changes per hour in the toxic room while maintaining a negative pressure differential of 0.15 to 0.20 inches of water. In order to maintain a flow of air in the buffer zone/airlock and decon room, the ventilation system draws air through these areas to the toxic room from the holding area.

e. References.

(1) Edgewood Arsenal CAMDS Test Summary, BIF-F-NA-EA(5185)-1-1, "Airflow and Structural Adequacy of Bulk Item Facility Building" by D'Andrea and Shacter, Sep 73. This test revealed that the structure adequately withstands negative pressure levels up to 0.64 inches of water.

(2) Test Report No. CAMDS 21-1, "Drill Test of Empty MC-1 Bomb", by D'Andrea, 7 April 1975. A Gardner-Denver Model 92D10 air feed drill was tested in combination with a 3/4" diameter high speed steel bit and was found to provide sufficient power to penetrate the wall of the MC-1 bomb. See Incl 12.

(3) Test Report No. CAMDS 21-2, "Ton Container Handling/Drain Fixture Functional Tests" by D'Andrea, 15 July 75. This test verified satisfactory performance of the ton container handling/drain fixture, as shown on CAMDS drawing ECDS21-350-01, in terms of mechanical/hydraulic and weighing functions. This test also verified satisfactory plumbing and glove port interfaces with the ton container/fixture combination. See Incl 12.

4-16 AGENT DESTRUCTION SYSTEM (ADS)

a. Purpose. The Agent Destruction System processes liquid agents GB and VX. GB is detoxified by neutralization with aqueous sodium hydroxide; VX is detoxified by acid chlorinolysis with subsequent neutralization of the acidic reaction products with 50% aqueous sodium hydroxide. The ADS also supplies 18% sodium hydroxide to three other CAMDS subsystems: the Metal Parts Furnace (MPF), the Deactivation Furnace System (DFS), and the Central Decon System (CDS). The ADS also processes spent decon from all CAMDS sources to assure complete detoxification; drum dries all brines from the ADS, the MPF and the DFS; and packages them in 55-gallon fiber drums.

b. Description. The ADS housing is subdivided into toxic and nontoxic areas for reasons of personnel safety. All agent processing is performed in a toxic enclosure which is maintained under a negative pressure. The remainder of the housing contains the brine bulk reduction (drying) and utility units. The chemical storage tanks and the cooling tower will be located outside the ADS housing. The ADS includes a railroad tank car unloading station with an air compressor for unloading chlorine and hydrochloric acid.

(1) ADS housing. The prefabricated housing is approximately 70 feet wide by 160 feet long with a 22 foot ceiling. See Figure 4-32. The toxic cubicle is approximately 58 feet long by 48 feet wide with a 21 foot ceiling and is maintained under negative pressure.

(2) Area ventilation systems.

(a) Nontoxic areas. The nontoxic area is arranged into utility control and bulk reduction areas. The nontoxic area is maintained at atmospheric pressure. Air flow into the nontoxic area is about 25,000 CFM through the bulk reduction area supply air plenum. All inlet air is passed through a dust filter and is heated as required. This air is exhausted through the drum dryers.

(b) Toxic area. The toxic cubicle is designed for 25 air changes per hour. The total air flow into the toxic area is about 25,000 CFM through the cubicle area supply air plenum. Air is drawn into the cubicle through mechanically-operated louvers from the corridor. The cubicle is maintained at a negative pressure. Exhaust air is drawn from the cubicle to the filter system which is located just outside the housing.

(3) Process vent scrubber. The process vent scrubber system is located in the pit area of the toxic cubicle. Vents from all reaction vessels and agent and acid storage tanks are piped to the process vent scrubber for removal of trace quantities of agent or chemical vapor. Each header to a vent manifold has an air purge associated with it to prevent back contamination of other headers.

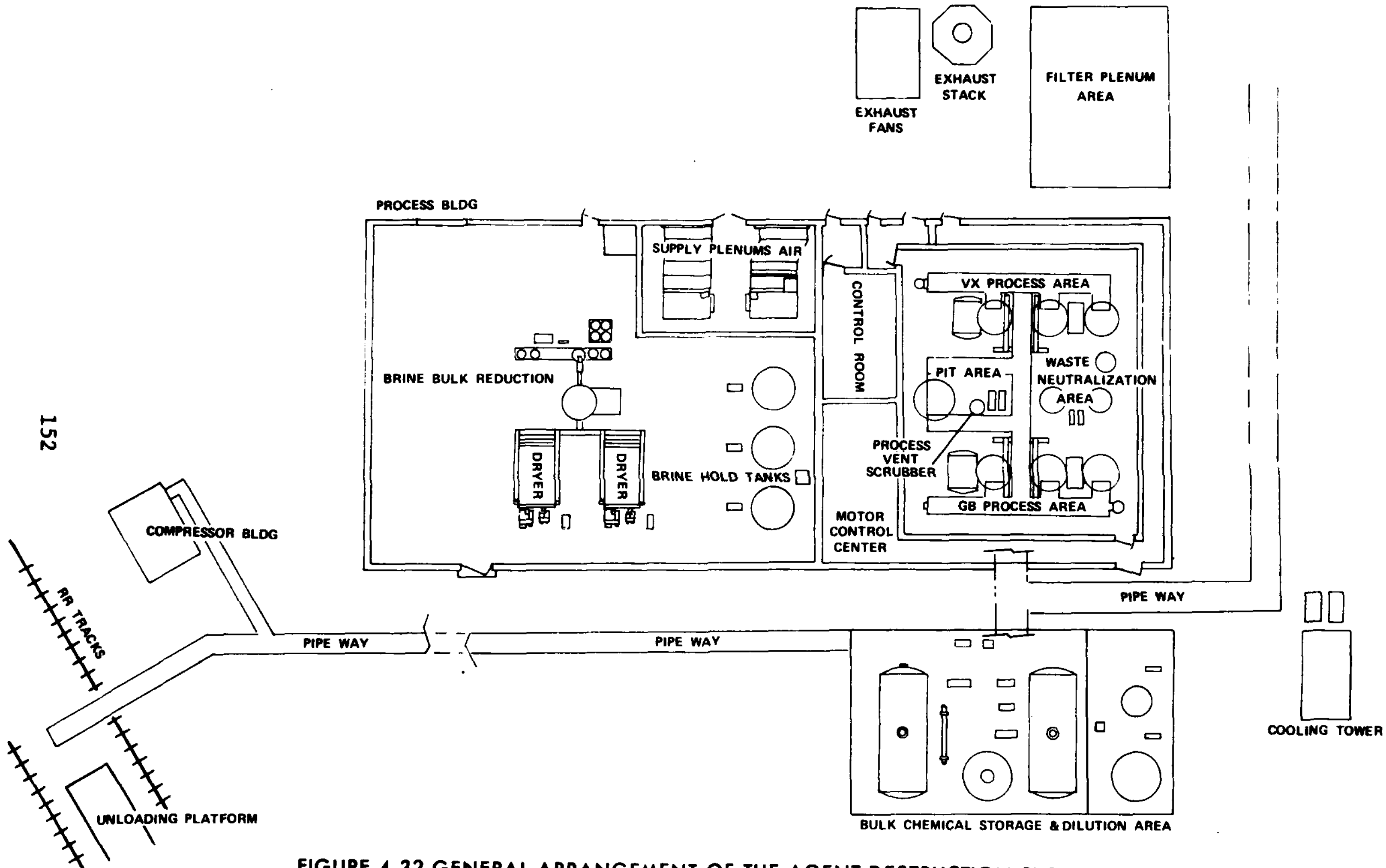


FIGURE 4-32 GENERAL ARRANGEMENT OF THE AGENT DESTRUCTION SYSTEM

The process vent scrubbing system utilizes a recirculating counter-flow-type packed tower with 18% caustic makeup. All vent gases pass through the tower for removal and conversion of any trace quantities of live agent or chemical before delivery to the charcoal filters and eventual release to atmosphere. Spent caustic is removed from the scrubbing system and replaced with a like amount of fresh caustic when the ph falls below 12. Spent caustic is routed to the waste neutralization tanks for final detoxification of any residual agent remaining in the scrubbing system. The normal air flow across the scrubber is about 10 CFM.

(4) GB process area. The principal process equipment for the neutralization of GB include: a GB storage tank, a GB batch tank; a caustic batch tank; and two parallel GB detoxification reactors, complete with overhead condensers, recirculation pumps and recirculation coolers. The GB storage tank has a working capacity of 3000 gallons. Agent from the demil facility is delivered to the GB storage tank through the agent piping. The storage tank is equipped with an agitator to keep solid matter in suspension during transfer operations to the 450 gallon process batch tank. The two GB detoxification reactors are vertical carbon steel vessels with a heating/cooling jacket and an agitator.

(5) VX process area. The principal equipment for the processing of VX include: a VX storage tank, a VX batch tank, an HCl batch tank, a chlorine batch tank, and two parallel VX detoxification reactors, complete with overhead condensers and transfer pumps. The reactors utilize a common heating/cooling recirculation system to their jackets composed of a jacket heater, a jacket cooler and recirculation pumps.

The VX storage tank has a working capacity of 3000 gallons. Agent from the demil facility is transferred to the VX storage tank through the agent piping. The storage tank is equipped with an agitator to keep solid matter in suspension during transfer operations to the 450 gallon process batch tank. The two VX detoxification reactors are glass-lined steel reactor vessels with a heating/cooling jacket and an agitator.

(6) Waste neutralization equipment. Two 1000-gallon capacity tanks are located in the toxic area. These tanks are provided to caustically neutralize any waste containing GB or VX. The two tanks receive waste collected in sumps from cleanup and washdown operations at other CAMDS facilities and the ADS itself. In the case of the ADS, waste material will be transferred to these tanks from the sump tank. In the case of the CAMDS waste, the spent caustic and other wastes will be delivered directly by pipeline.

(7) Bulk chemical storage and dilution equipment. A number of tanks and pumps are required to store and prepare chemicals used in the ADS detoxification processes and in other CAMDS systems.

(a) Chemical storage tanks. Three tanks are available for bulk chemical storage, one tank each for 35% hydrochloric acid, 50% and 18% sodium hydroxide. Catch basins are erected around the storage tanks to assure containment of the chemicals in event of tank leakage or rupture. There is one catch basin which is used for the sodium hydroxide storage tank and dilution tank area and a second catch basin is used for the hydrochloric acid storage tank and dilution tank area. Each catch basin is designed to hold 110% of the aggregate capacity of the tanks in that area. Bulk chemicals are delivered to the site by railroad tank car. Tank car unloading facilities are located outside the fence approximately 200 feet from the ADS housing.

(b) Dilution tanks. Dilution tanks for hydrochloric acid (HCl) and caustic soda are available since these chemicals must be diluted with water to proper strength for use in the detoxification processes. The HCl, which is 35% strength in the storage tank, is reduced to 6% in the dilution tank, approximately 1.5 N acid. The 6% HCl is then stored in the HCl dilution tank for process used. Caustic, which is 50% in strength in the storage tank, must be diluted for use in the ADS processes as well as for other CAMDS services. The caustic will be diluted in the caustic dilution tank and stored in the caustic storage tank. The caustic dilution tank is equipped with a heat exchanger to remove the heat generated during the dilution process.

c. Rail tank car will serve as Bulk Chlorine storage tank.

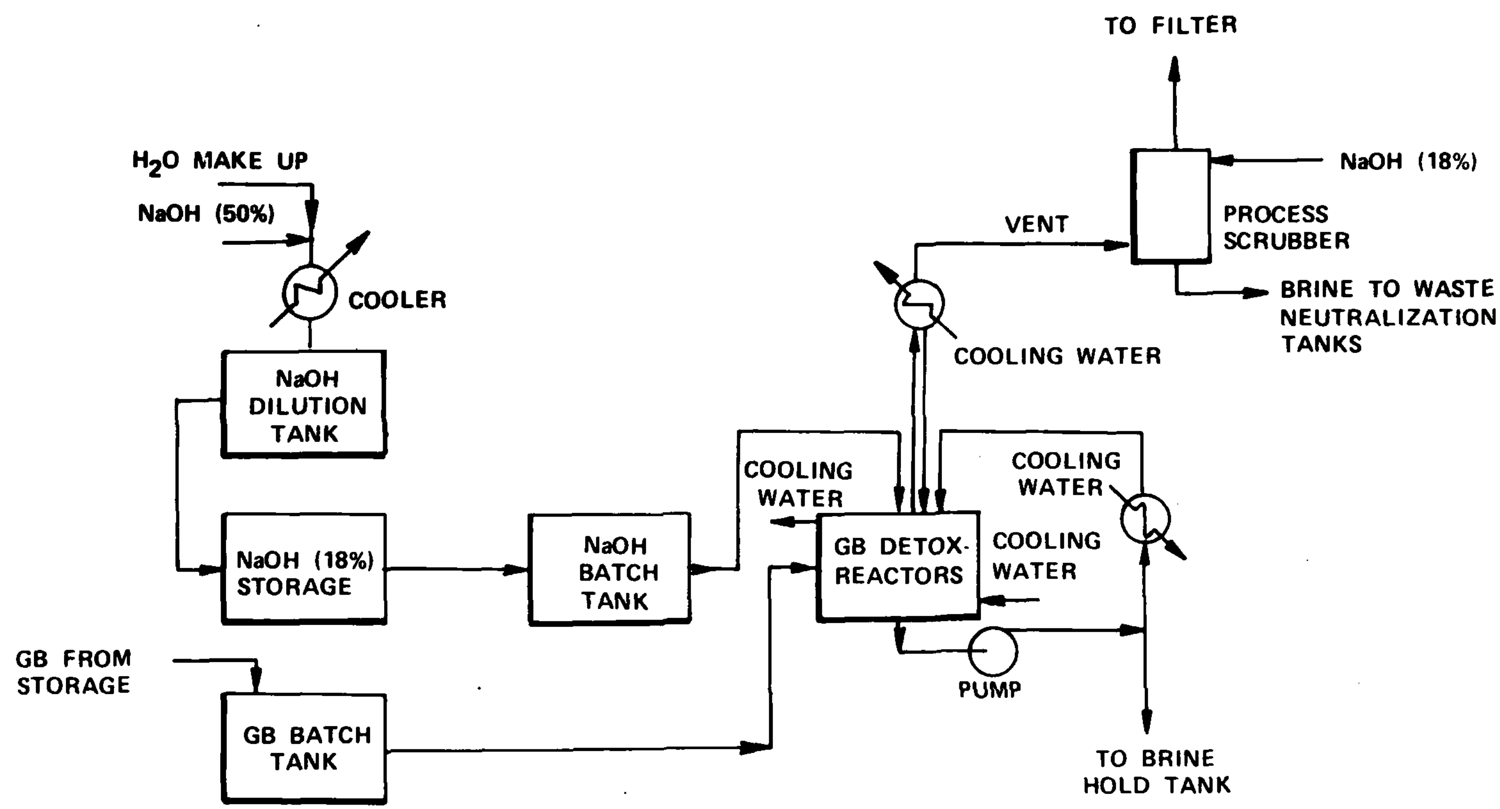
(8) Brine bulk reduction equipment. The basic equipment for the reduction of brine to salt include: 45000 gal capacity brine holding tanks with transfer pumps, two parallel steam heated twin-drum dryers with recirculating pumps, a common salt conveyor system, salt storage bin, and a salt compactor.

The controls for the brine drying process are basically manual in nature. The instrumentation and controls are locally mounted or situated in a nearby control panel. The brine holding tanks are equipped with level indicators. The dryer is equipped with a sump level indicator and a speed indicator. The dryer steam heating system has an orifice plate element, transmitter, and recorder to measure flow.

The solids discharging from the dryers are conveyed to a surge bin equipped with a level indicator. The solids compactor has a meter to measure the electrical loading on the motor. The solids from the compactor are fed into storage drums which go to final storage. See Section 6 for details of the certification and disposition of the salts.

c. <u>Operation</u>

(1) GB detoxification. One of the GB reactors is selected and the applicable automatic process controls are set up. See Process Flow Sheet Figure 4-33. Both batch tanks are then filled with the correct amounts of GB and sodium hydroxide. A heel of caustic is first added to the reaction vessel and then the caustic and GB are gravity fed simultaneously into the reactor until the batch tanks have been emptied. The



GB DETOXIFICATION FLOW SHEET
FIGURE 4-33

reaction is exothermic, necessitating removal of the heat of reaction by circulating the agent/caustic solution through a recirculation cooler and back to the reaction vessel. The overhead condensers serve to reflux any vapors that form during the reaction. Should the reaction temperature exceed 190°F, the GB flow is automatically reduced or terminated thus quenching the reaction. At least 5% excess caustic is added to assure complete GB detoxification. The reaction will require about 3 hours time before complete GB detoxification is achieved.

On completion of the reaction, a sample is drawn and taken to the laboratory to determine excess caustic. If the brine contains the required 5 percent excess sodium hydroxide, it is then pumped to the brine holding tanks or the bulk reduction section. If the brine fails the test, additional sodium hydroxide is added to the reactor and another sample will be drawn for certification of excess sodium hydroxide.

The brine is processed, either on a semi-continuous basis or on an as-required basis, through the drum dryer system to form a salt. See Figure 4-34. Where required, the salt will be pelletized in the compactor to ease handling and reduce storage.

(2) VX detoxification. The VX detoxification process consists of two steps. The first step is an acid chlorinolysis reaction (see Figure 4-35) and the second step is caustic neutralization of the acid solution formed in the first step (see Figure 4-36). In order to conserve acid, the process is designed to recycle the acid formed during the reaction of the VX with chlorine in subsequent reaction batches. A complete series of runs consists of an initial, fresh acid run followed by six recycle runs. In the initial run, fresh 1.5 N hydrochloric acid (HCl) is fed to the batch tank. In all succeeding runs, a portion of the decon solution from the previous run is recycled to the batch tank and diluted in water (two parts water to one part acid solution, by volume) in the reactor.

(a) Acid chlorinolysis. In this step of the VX detoxification process, the chlorine reacts chemically with the VX acid solution to form O-ethylmethyl phosphonic acid, di-isopropyltaurine, and more HCl.

To initiate process operations, one of the VX detoxification reactors is selected and the applicable automatic process controls are set up. All three batch tanks are then filled with the correct proportions of VX, 1.5 N HCl or acid recycle solution, and chlorine. The sequence of chemical addition to the reactor in this step is quite critical to prevent the hypergolic reaction of VX and chlorine. First the HCl is gravity fed to the reactor. Then the VX is added by gravity feed to the HCl in the reactor to solubilize the VX before the chlorine is added. To start the reaction, chlorine is slowly fed from the batch tank to the reactor. The reaction is quite exothermic and the reaction

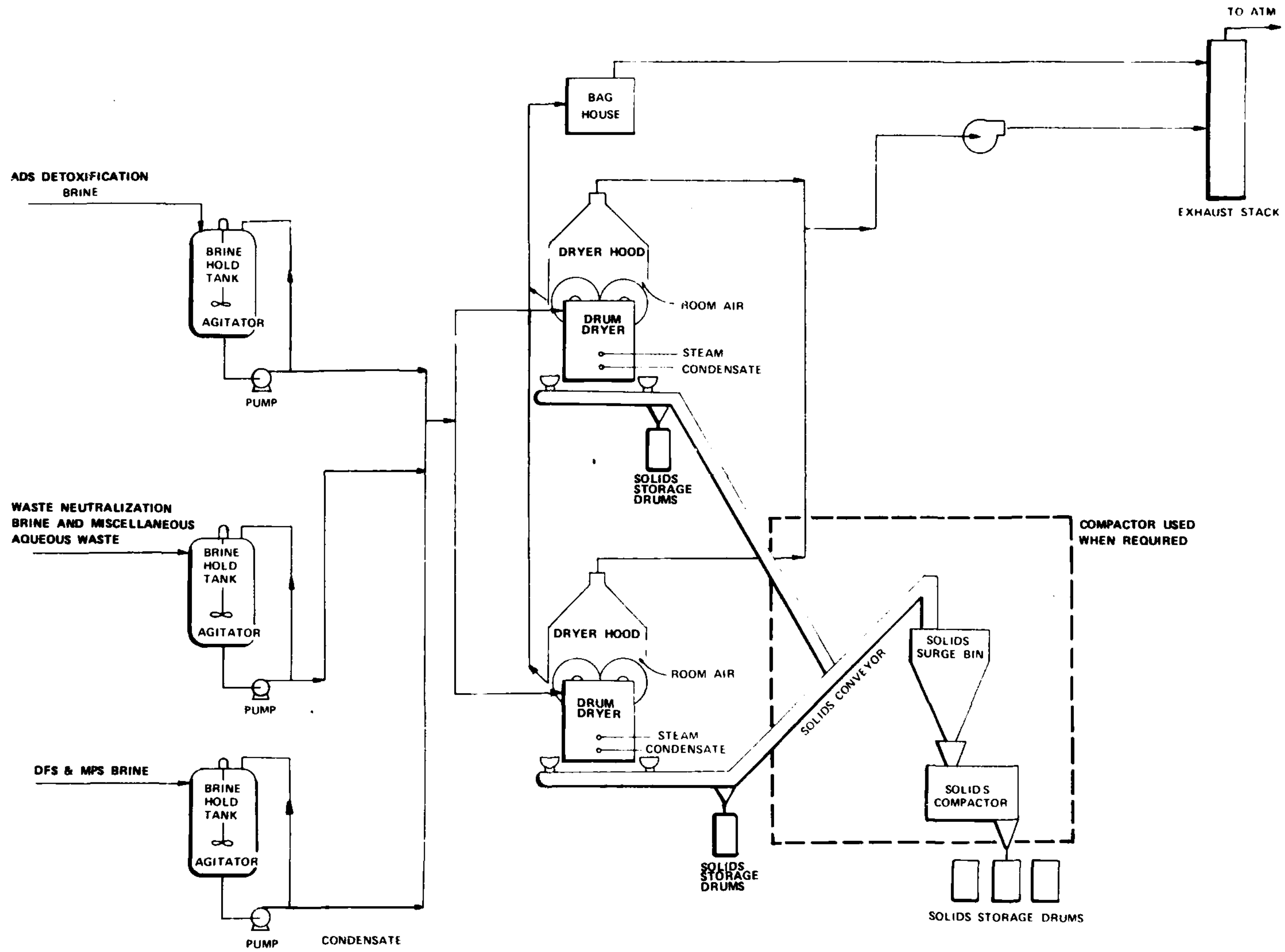
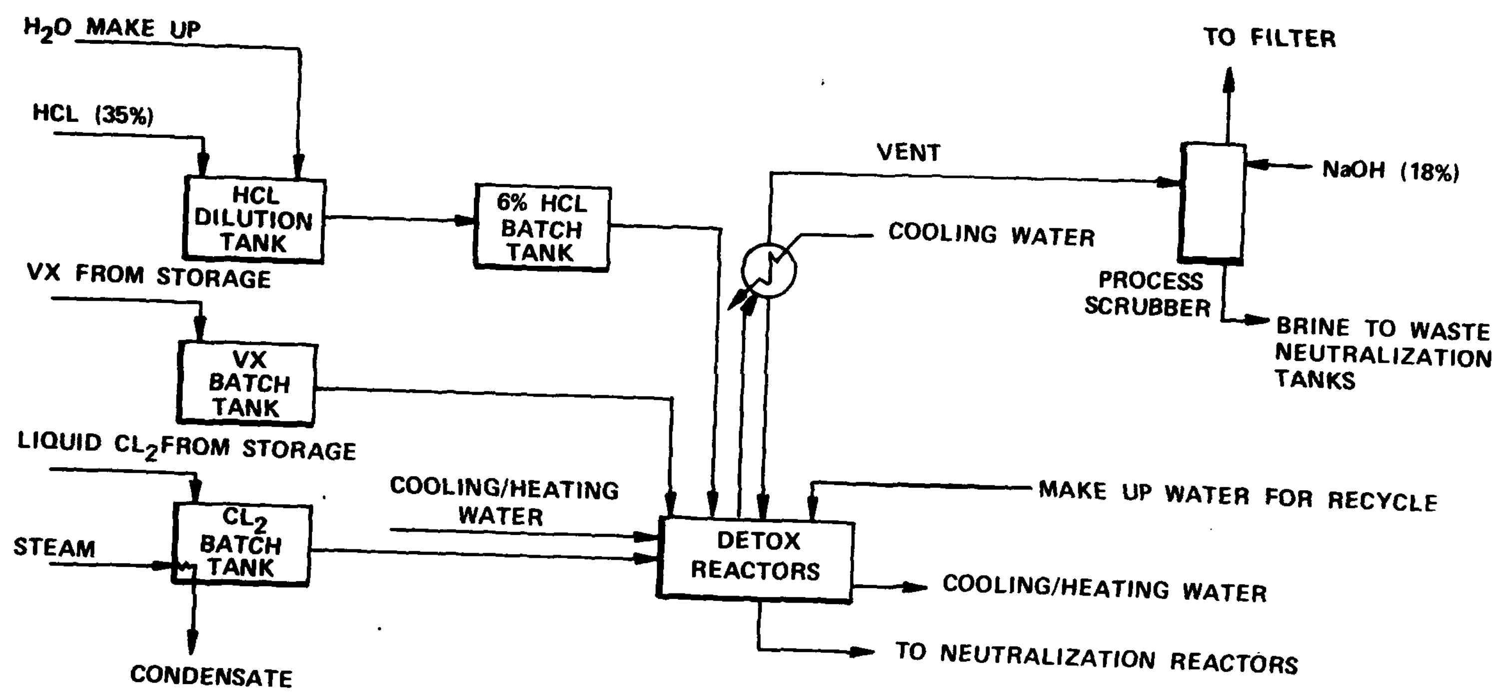
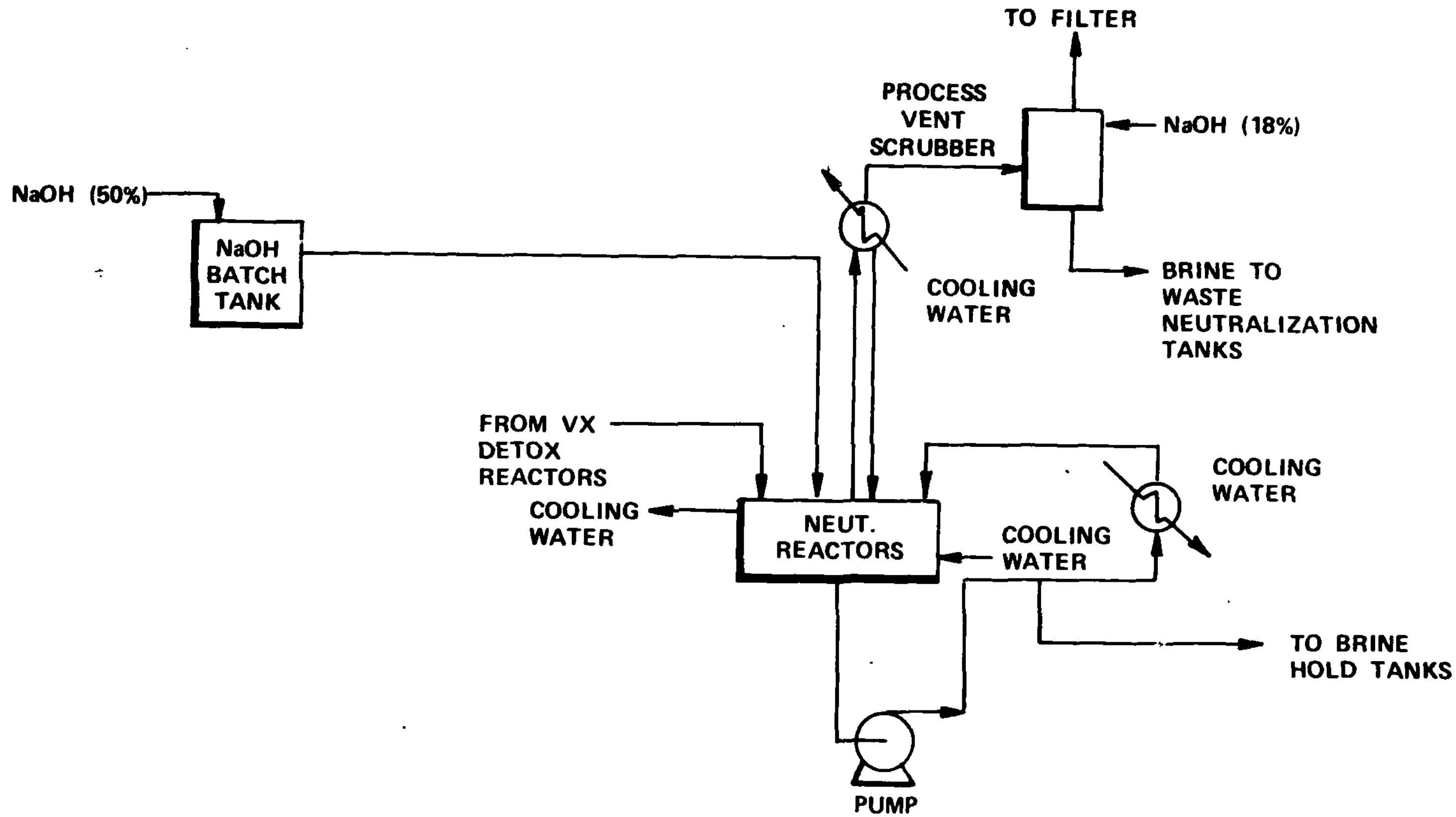


FIGURE 4-34 BRINE REDUCTION FLOW SHEET



ACID CHLORINOLYSIS OF VX FLOW SHEET

FIGURE 4-35



CAUSTIC NEUTRALIZATION OF VX REACTION PRODUCTS
–FLOW SHEET
FIGURE 4-36

temperature will peak out at approximately 220°F. The VX agent contains a stabilizer which must be kept in solution during the course of the reaction to insure complete detoxification. To accomplish this, it may be necessary to add external heat from the jacket heating system for a thirty minute period after the reaction temperature has peaked out. Approximately 30 percent excess chlorine must be added to insure complete detoxification of the VX solution.

Acid and water vapors distilled off during the course of the reaction are refluxed in the overhead condenser. Unreacted chlorine passes through the overhead condenser and is chemically converted to NaOCl and NaCl in the process vent scrubber system.

The reactor jacket cooling system is used primarily to remove the heat of reaction during chlorination of the VX. Should reaction temperatures become excessively high (over 260°F), the chlorine flow will be reduced or terminated automatically thus quenching the reaction. It is also used to remove the heat of solution caused by dissolving the VX in the HCl.

Approximately three hours of reaction time is required to assure that all VX has been completely detoxified. Upon completion of the reaction, a sample is drawn and submitted to the laboratory for an agent activity test. If the decon solution residual agent activity is acceptable, the decon solution is then transferred to a GB detox reactor for the neutralization step. If not acceptable, additional chlorine is added to the reactor and sampling is repeated.

(b) Caustic neutralization. The acidic solution from the acid chlorination step of the overall process must be neutralized with caustic to make a brine that can be handled by the drying equipment. This necessitates adding 18% or 50% caustic to raise the pH from 1-2 to 9-11 and convert the acid reaction products to salt forms.

The action of caustic with the acid decon solution produces the sodium salt of O-ethylmethyl phosphonic acid and di-isopropyltaurine, and sodium chloride as nontoxic end products.

To start the process, a reactor system is selected and the caustic batch tank charged with sufficient caustic to assure complete neutralization of the VX decon solution. In most cases, ten percent excess caustic will be added to assure that the resultant brine solution attains a pH in the range of 9-11. After the caustic has been added, the VX acid decon solution is slowly fed into the GB reactor from a VX detox reactor. The reaction between the caustic and acid solution is somewhat exothermic and the solution temperature will rise to approximately 175°F. The heat of reaction will be removed by circulating the resultant brine solution through the recirculation coolers.

The reaction products resulting from caustic neutralization are principally sodium organic salts and sodium chloride. Some of the salts precipitate during the course of the reaction forming a brine slurry. When neutralization operations are completed, this brine slurry is transferred to the brine holding tanks in the bulk reduction section for ultimate disposal as pelletized salt.

(3) Waste neutralization operation. This operation is an integral part of both the GB or VX processing system. All liquid waste generated in the ADS toxic cubicle from agent spills, leaks, or caustic washdowns first passes through floor drains to the sump tank. From there it is pumped to the waste neutralization tanks. Spent caustic from the process vent scrubber is also dumped to the tanks. In addition, these tanks handle similar waste originating in other parts of the CAMDS facility, namely waste from the Metal Parts Furnace, the Deactivation Furnace System, the Bulk Item Facility, the Explosive Containment Cubicle, the Projectile Pull and Drain Machine and Explosive Treatment System.

Once these wastes reach the waste neutralization tanks during GB operations, sufficient sodium hydroxide is added to provide for a 5 percent excess sodium hydroxide/carbonate. In the case of VX operations, caustic is added to complete the detoxification although a long residence time will be required. Prior to transfer to the waste brine holding tanks in the bulk reduction (drying) area, the solution will be sampled and analyzed for excess caustic or enzymatic activity to certify it is free of agent.

The controls for the waste neutralization tanks are basically semi-automatic to accommodate the wide range of potential detoxification batch operations that they must control. The same basic instrumentation is used on both tanks, and include temperature, level recorders, and various alarms. The sump tank, which is below grade, is equipped with a level indicator and alarm.

d. Safety. The toxic cubicle is considered a contaminated area and operators will wear level A protective clothing within the cubicle. Entry and exit from the cubicle will be through an airlock equipped with a fresh water shower and an M8 agent detector probe. Prior to leaving the toxic cubicle, operators will scrub their protective clothing with appropriate decon solution (sodium hydroxide or hypochlorite solution for GB and VX respectively). The protective suit will be showered and the operators will probe for agent using the buddy system. If the test is negative, the boots and gloves will be removed. The operators will then move to the undress area, remove the suit and place it in a plastic bag. The operators will leave the area still wearing their respirators. The remainder of the ADS housing will be non-contaminated. Operators will wear safety shoes and cotton gloves during palletizing

of drums. Eye protection will be worn when handling caustic or acid. Eye washes and safety showers are available in the ADS area.

The ADS system has been instrumented with controls to assure fail-safe, automated operation in all critical areas to reduce hazards to operating personnel and to prevent damage to equipment. Both the GB and VX detoxification systems operate semi-automatically to a specific sequence of interlocking steps. Interlocks are also provided between critical equipment, such as reactors, pumps and valves, to prevent premature operation.

All critical, electrically-powered process equipment in the toxic area (toxic cubicle and filters) and other critical equipment will be tied into the CAMDS emergency power network to provide for the completion of detoxification of any batch in the reactor to allow a safe and orderly shutdown of equipment, and to assure that toxic materials are fully contained in the event of commercial power failure.

All toxic operations are performed in an enclosure under negative pressure (-0.15 inch water gauge). These operational areas also undergo 25 air changes per hour and all exhaust air is released to the atmosphere after passing through a filter system.

The toxic area enclosure has sufficient windows to permit visual surveillance during maintenance operations. Closed circuit television is provided for surveillance of the pit and upper operating areas.

e. References.

(1) Report by G. W. Thomas, Manufacturing Technology Directorate, Edgewood Arsenal, MD, "Pilot Scale GB Neutralization Studies," December, 1972. Verified the suitability of the GB caustic neutralization process as employed at Rocky Mountain Arsenal. See Incl 10.

(2) Report submitted by Stearns-Roger Inc., Denver, Co, under contract DAAA15-74-C-0063, "GB/VX Chemical Neutralization Process Studies, Final Evaluation Report Piloting Test Program," November 1974. Summarizes and evaluates all process data and design information acquired from various pilot plant test programs prior to August 1974. The acid chlorination process was found to be a viable means of detoxifying VX. Any changes in the Rocky Mountain Arsenal process of GB caustic neutralization would be incorporated into the ADS final design. Drum drying of both agent neutralized brines appears to be the most viable and economical process. See Incl 10.

(3) Engineering Accomplishment Report I by Stearns-Roger Inc., Denver, CO, under contract DAAA15-74-C-0063, "Conceptual Process Design of the Agent Destruction System (ADS) for CAMDS," July 1974. Provides the process design and engineering for the ADS.

(4) Engineering Accomplishment Report II by Stearns-Roger Inc., Denver, CO, under contract DAAA15-74-C-0063, "Conceptual Process Design of the Agent Destruction System (ADS) for CAMDS," November 1974. Provides the engineering design of the ADS process equipment and facilities.

4-17 DUNNAGE INCINERATOR (DUN)

a. Purpose. The DUN will be used to burn all unsalvageable packing materials, pallets, skids, separators, etc. removed from munitions at the Unpack Area. Materials contaminated with agent will not be processed in this unit, but will be disposed of in the Metal Parts Furnace.

b. Description. The DUN is a commercial multiple-chamber oil-fired incinerator with an induced draft fan and a wet scrubber module. See Figure 4-37. The dunnage will be processed without violating Federal, State and local air and water quality standards. Stationary power saws equipped with a sawdust collection system are located near the incinerator for cutting the dunnage into a suitable size for burning. Scales are available to weigh the dunnage. The incinerator has the capacity to process 500 lbs/hr of uncontaminated dunnage composed of wooden pallets and combustible packing material. The incinerator and its auxiliary equipment will be housed in a prefabricated metal shelter.

c. Operation. The DUN operators start the incinerator when sufficient amount of dunnage from the UPA is delivered to the DUN facility. The operator allows the internal operating temperature to reach 800°F before charging the firebox with any dunnage. The incinerator will be fed in approximately 125 lb increments.

The waste material is placed in the ignition chamber of the incinerator through the charging door. Flames pass through flame ports into a mixing chamber where additional air is provided, and then through a curtain wall port into the combustion chamber where final oxidation of combustible products occurs. The resulting gases are discharged through the scrubber section for cooling and removal of remaining fly ash by recirculating water sprays. The scrubbed gases are then removed by induced draft through the stack into the atmosphere.

When the incineration operation reaches its peak, the operators will continually inspect the temperature recorder and ensure that the temperature remains in the range of 800°F to 1400°F. Should the temperature exceed 1400°F, the charging operation will be slowed down or stopped until the temperature drops within the operating range.

The incinerator is shut down when the amount of dunnage available has been reduced to the point where it is no longer feasible to continue the operation. During waiting periods, the DUN operators can cut the large pieces of dunnage (with the use of the dunnage saw) into smaller pieces that will fit into the incinerator. The sawdust collected during sawing operation will be burned in the incinerator.

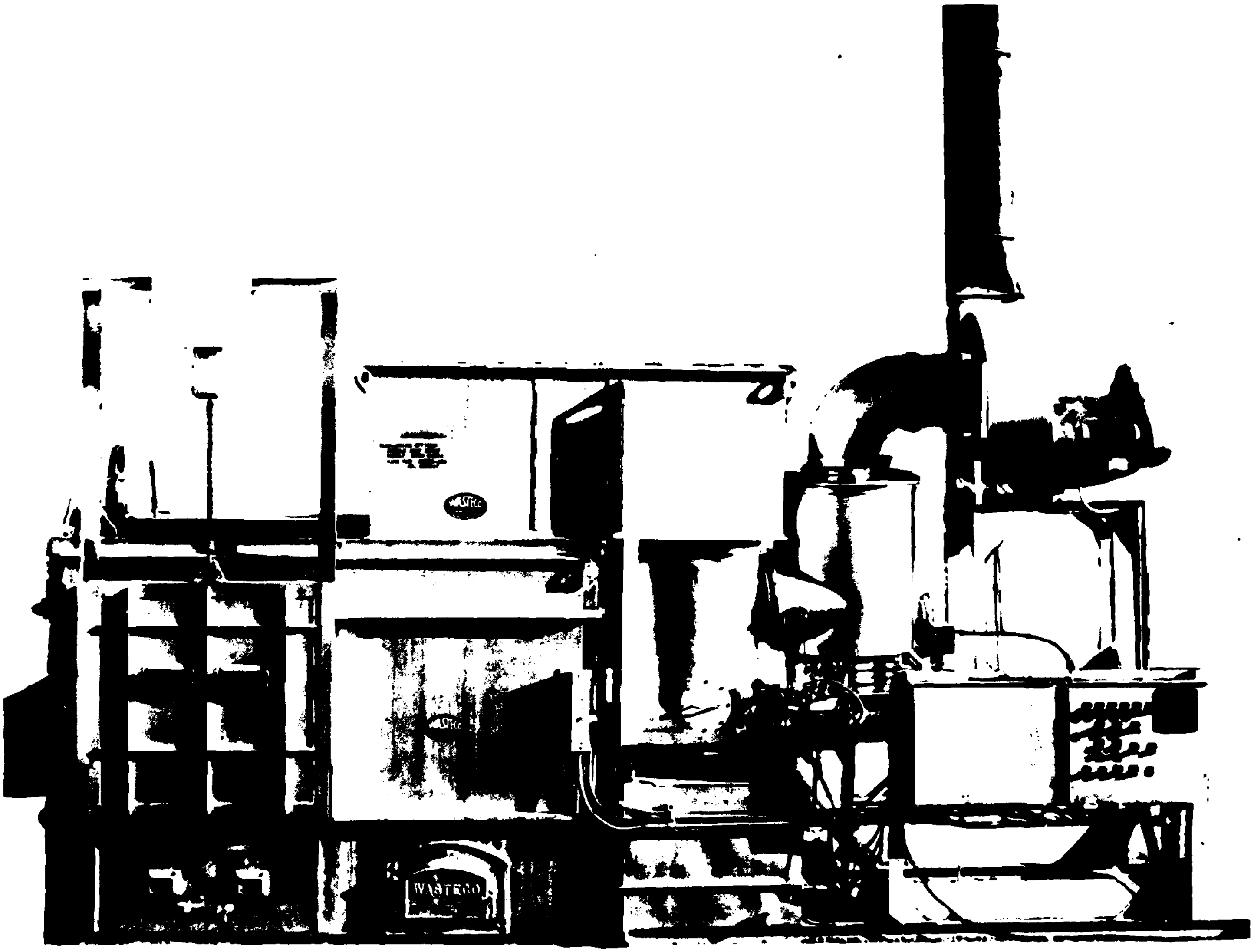


FIGURE 4-37 DUNNAGE INCINERATOR

The ash is removed from the incinerator manually with a scraper and placed in a hopper. The ash hopper is moved outside where the ash is cooled for later removal to the landfill. Scrubber sludge (fly ash and water) is collected in a storage tank for removal to the landfill.

d. Safety. Operators will be required to wear safety shoes at all times, ear and eye protection during all sawing operations and eye protection when handling dunnage that contains metal bands and nails. Leather palm gloves will be worn while handling all dunnage.

e. References.

Report by US Army Environmental Hygiene Agency, "Air Pollution Engineering Source Sampling Survey No. 99-06-72, Acceptance Test of TDS Dunnage Incinerator, Tooele Army Depot, Tooele, Utah", 10 Mar 1972. Particulate and visible emissions from the Dunnage Incinerator did not exceed the standards governing its operation in Utah at a dunnage charging rate of 500 lb/hr or less. See Incl 15.

4-18 CONTROL CENTER (CON)

a. Purpose. The Control Center provides the housing for all centralized control equipment of the CAMDS, including the computer control system, and provides office space for shift engineers and operating personnel.

b. Description. (Figure 4-38). The Control Center consists of two 50' x 10' prefabricated, heated and air conditioned trailers. One structure contains the computer and other equipment used to control and monitor the CAMDS facility and processes. In addition to the Hewlett Packard digital computer used to control conveyors and munition handling equipment in the Explosive Containment Cubicle and the Projectile Disassembly Facility, the center contains control panels for the Explosive Treatment System, the Central Decon System, the Deactivation Furnace, and the Metal Parts Furnace. TV monitors and electronic monitoring instruments for the Agent Destruction System are also contained in this area. Design panels with alarms will indicate the operation of automatic agent detectors, the negative air pressure in the toxic enclosures, and the air flow through the charcoal filter units servicing the toxic process areas. Figure 4-39 is an artist's concept of the control equipment installed in the Control Center. The other structure contains a computer terminal, two television monitors and working space for personnel. The two structures are physically joined together with a glass partition separating the two areas.

c. Operation. All activities at the CAMDS site are coordinated from the Control Center. All equipment at the CAMDS is either directly controlled or monitored from the CON. Closed circuit television provides visual monitoring of the equipment under direct control of the computer and operations in contaminated areas not under computer control. Remote sensing, recording and readout devices in the Control Center monitor critical points and operating parameters in the CAMDS. Interconnection between the remote sensors and the computer provide automatic annunciation of equipment or operation deviations to the Control Center operator. The Control Center is supervised by the shift engineer. Up to three control room operators will be stationed at the control panel. Access will be limited to these essential people. No more than two transients will be allowed in the Control Center with the permission of the shift engineer. The Control Center is partitioned into two rooms, the control room and the office area. Quality control and production control personnel utilize this office space in addition to the control room personnel. In the event of a malfunction, the shift engineer is the only individual for directing system overrides. Actions taken for specific circumstances will be noted in the computer printout and control room log both of which must be signed by the shift engineer.

d. Safety. Overall safety of the CAMDS is controlled from the Control Center. The automatic process monitoring system alerts the CON operator not only of equipment or operational failures but also of deviations from the norm before they reach a critical state. Through use of the intercommunication system, the Control Center operator can initiate corrective actions or interrupt operations until the deviation is corrected. In the remote event of agent release to the atmosphere in the CAMDS area representing a danger to the staff, CON operators will immediately mask and activate the necessary controls for automatic shutdown of the equipment controlled from the center. They will then evacuate to an upwind area with the remainder of the CAMDS staff while cleanup and decontamination is accomplished by engineering teams in level A protective clothing.

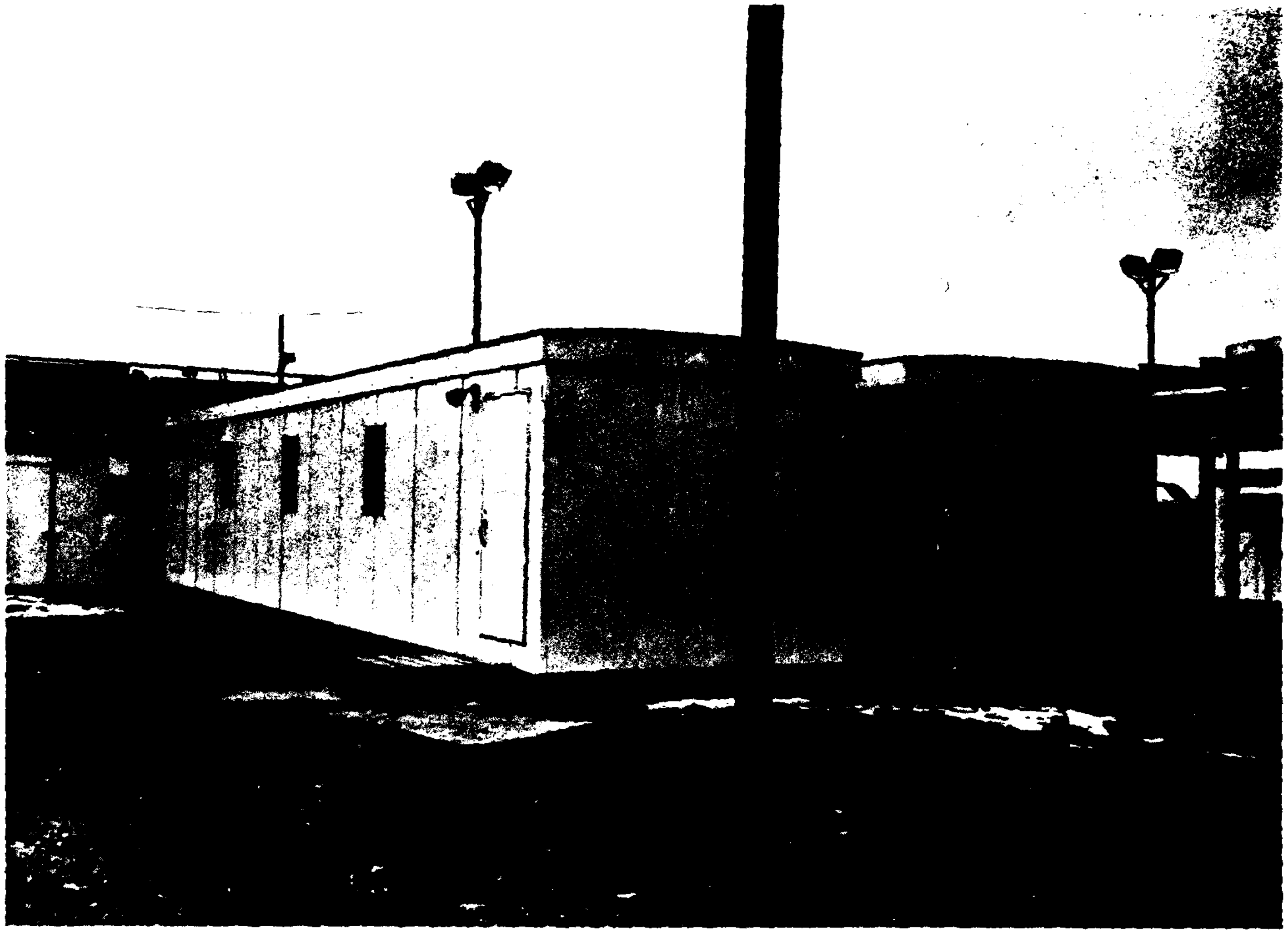


FIGURE 4-38 CONTROL CENTER

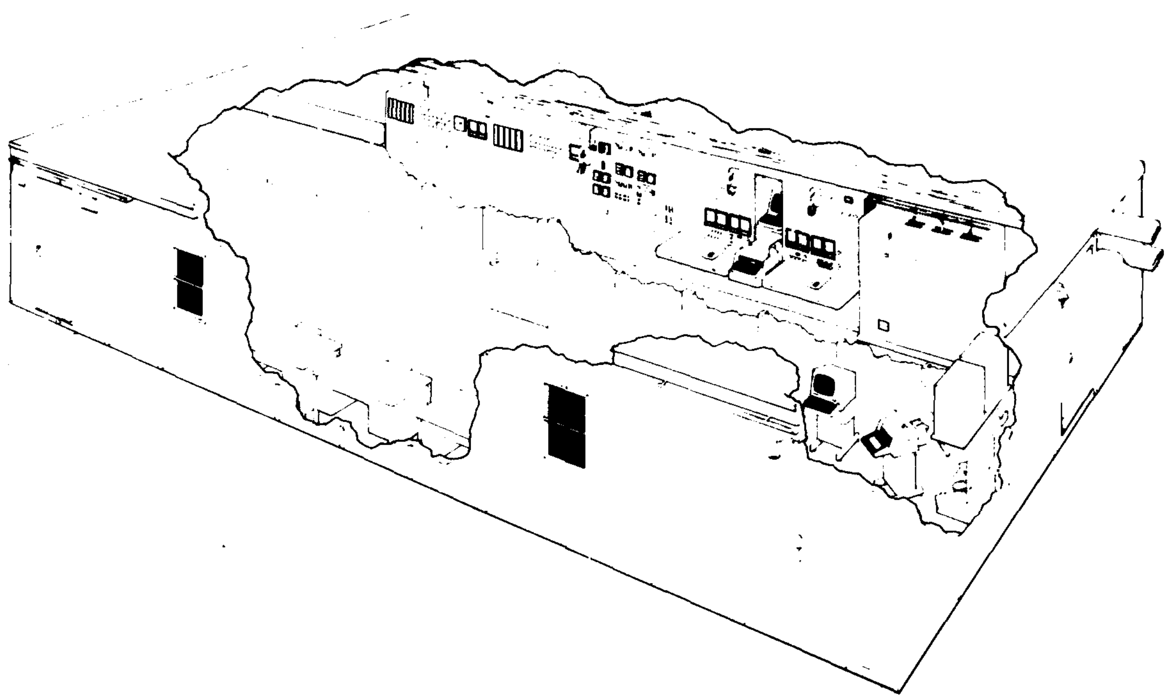


FIGURE 4-39 CAMDS CONTROL MODULE

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OPERATION OF THE CHEMICAL AGENT MUNITIONS DISPOSAL SYSTEM (CAMD--ETC(U)
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4-19 COMPUTER CONTROL SYSTEM (CCS)

a. Purpose. The purpose of the CCS is to provide a means of automatic control of demil equipment and to monitor operations in critical areas.

b. Description The basic demilitarization machine and conveyors are under the direct control of a computer based system which allows logic and operational sequences to be stored in memory rather than being hardwired with switches, relays, or other electronic/electrical components. Figure 4-40 is a block diagram of the major computer components. Some of the computer hardware is shown in Figure 4-41.

The system has the capability of processing digital inputs, i.e., the opening or closing of remote switch or sensor contacts. Actuation power for input circuitry is 48 volts DC supplied by the control system. The digital inputs integrated with the logic and sequence data stored in memory are processed by the computer resulting in computer digital outputs, i.e., turning on or off solid state switching relays in the computer. The digital outputs, in turn, control the machine control devices such as solenoid valves and motor starters. The actuation power for the machine control devices is 110 volts AC supplied from the machine control devices to the switching relays in the computer.

Other circuit boards are used in the output interface to supply other types of output signals such as stepping switches and timing controls used to control indexing operations. The computer also has analog input and output capabilities used to monitor and control signals of a quantitative nature.

Table 4-3 shows the relation between the computer and the CAMDS equipment.

c. Operation. There are three operational modes available in the control system. The system is interlocked so only one operational mode can be used at a time.

The first operational mode is direct computer control. This mode is completely automatic and the one normally used. The computer receives all instructions from the memory disc.

The second mode is a multi-programmer control and is semi-automatic. This mode is used when a specific machine function or operation does not operate properly and has to be recycled after the malfunction has been corrected. The memory disc is turned off and the operator controls the computer directly from the multi-programmer. The multi-programmer has a display panel that shows the status of the computer inputs and outputs. It also has control switches which the operator uses to control the status of the computer inputs and outputs.

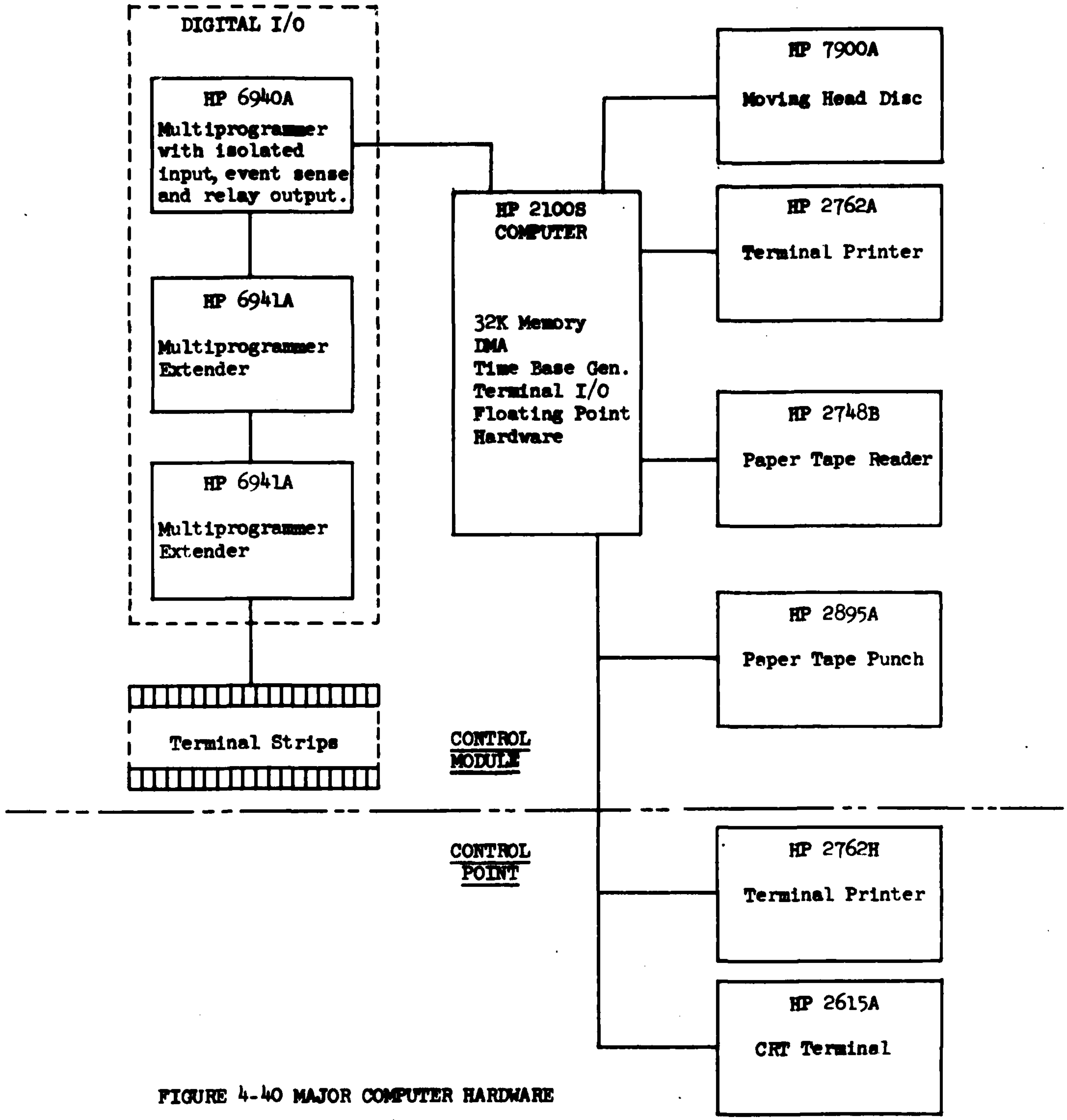


FIGURE 4-40 MAJOR COMPUTER HARDWARE

FIGURE 4-41 COMPUTER CONTROL CENTER

TABLE 4-3

Computer Relationship to CAMDS Equipment

Computer Controlled and Monitored	Separately Controlled Computer Monitored	Separately Controlled Separately Monitored
Explosive Containment Cubicle	Unpack Area	Dunnage Incinerator
Rocket Demil Machine	Deactivation Furnace	Electrical Distribution System
Projectile Demil Machine	Metal Parts Furnace	Perimeter Monitoring System
Projectile Pull and Drain Machine	Utilities Module	Closed Circuit Television System
Conveyors	Agent Destruction System	Communications System
Mortar Demil Machine	Explosive Treatment System	Chemical Laboratory
Mine Demil Machine	Central Decon System	
Piping System	Bulk Item Facility	
	Filter System	
	Agent Detectors	

The third system is manual control which allows the operator direct control of the demil equipment. The computer is turned off and the operator controls the equipment using switches on a manual control panel. The manual control system is used to operate equipment out of sequence when maintenance operations are being performed.

d. Safety. Some of the inputs to the computer act as safety interlocks. The computer system continuously monitors critical operating parameters (temperature, pressure, agent levels, etc.) and sequential machine operations. If a hazardous condition develops, such as high agent level, etc., or if a machine fails to complete a function, the computer will interrupt the related operations and print out the reason for the interruption. After the computer prints out the reason for interruption, the steps necessary to correct the condition will be taken at the direction of the shift engineer. Critical operations which have safety considerations require a double override and the computer print-out has a signature block which the shift engineer must sign specifying the reason for override. The computer system is connected to the standby emergency system so control of critical equipment can be maintained in case of a commercial power failure.

4-20 FILTER SYSTEM (FIL)

a. Purpose. The air filters, in conjunction with the ventilation systems of the various CAMDS enclosures, will insure containment of all airborne contamination within the toxic enclosures, localize contamination at the source to minimize the hazard to protected personnel who must enter the toxic enclosure, and filter contamination from the exhaust air.

b. Description. The Filter System consists of eleven air filter units to serve the various CAMDS toxic enclosures as shown in Table 4-4. Figure 4-42 shows the locations of these filter units at the CAMDS site.

TABLE 4-4

FILTER LOCATIONS AND CAPACITIES

	Location	Capacity	Quantity
(1)	Personnel Support Complex (including demilitarization protective ensemble (DPE) transporter vehicle)	333 CFM	1
(2)	Explosive Treatment System	2000 CFM	1
(3)	PDF Input Conveyor and Local Ventilation of PPD Machine	2000 CFM	1
(4)	Unpack Area	3000 CFM	1
(5)	Bulk Item Facility	3000 CFM	1
(6)	Metal Parts Furnace	4000 CFM	1
(7)	ECC Cubicle and Housing	6000 CFM	1
(8)	Deactivation Furnace System	6000 CFM	1
(9)	PDF Output Conveyor, PPD Shroud, and Multiposition Loader of the MPF	8000 CFM	1
(10)	Medical Module	2000 CFM	1
(11)	Agent Destruction System (including agent pipe shrouds & toxic maintenance trailer)	15000 CFM	2

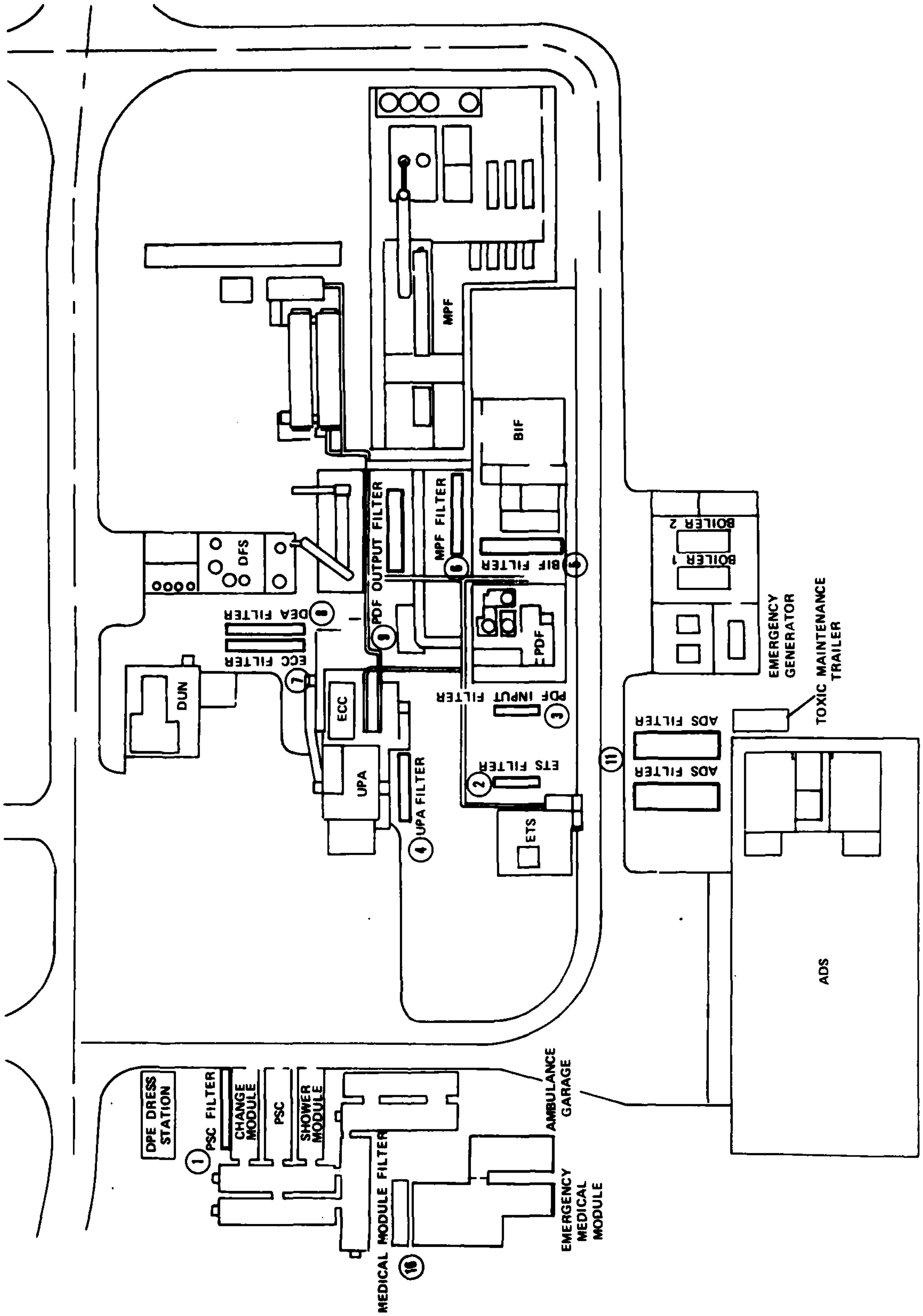


FIGURE 4-42 FILTER SYSTEM LOCATIONS

Each air filter unit contains a filter train and motor/blower in a skid-mounted housing. The filter train consists of prefilters, high efficiency particulate air (HEPA) filters, activated charcoal filters, a second bank of charcoal filters, and a second bank of HEPA filters. The blowers are equipped with adjustable outlet dampers (6000 cfm and less) or variable inlet vanes (8000 cfm and above) which will maintain relatively constant air flow throughout the useful life of the filters. Each filter bank is provided with gages to indicate pressure drop across the filters. Sampling ports are provided between the banks of charcoal filters and in the exhaust stack.

Although each filter unit is intended to serve a specific toxic enclosure, ducting and manually operated dampers are provided between filter units in the same area to provide some back-up ventilation capability when a filter unit is down for repair or replacement of filters. In the case of the Agent Destruction System, there are two filter units in parallel so that at least half of the ventilation flow can always be maintained.

c. Operation. Each filter unit is controlled from the Control Center except for the filter units on the Agent Destruction System (ADS). They are controlled from the ADS control room. Air flow at the filter unit and negative pressure in each toxic enclosure are monitored at the Control Center and the loss of either flow or negative pressure will actuate an alarm. The filter unit is started prior to the introduction of toxic materials into any enclosure and is operated continuously until the enclosure is decontaminated and certified clean following toxic operations.

Prefilters and HEPA filters are replaced when the pressure drop across the filters exceeds two inches of water for the prefilter and three inches of water for the HEPA filter. Pressure drop is visually indicated at the filter unit and is monitored on a daily basis. The air flow alarm is automatic and indicates when air flow falls below 90% of the preset value. An M8 and 1-hour bubblers are used as detectors between the charcoal filter banks. When the contamination level exceeds 0.2 mg/m^3, the threshold of the M8 detector, agent sampling is switched to the exit of the second filter and replacement of the charcoal filters will be scheduled for the next operational shutdown. The inside of the filter housings will be cleaned by personnel in level A protective clothing using an appropriate decon solution when replacing filter elements. The decon solution will be collected and sent to the waste neutralization tank of the Agent Destruction System for disposal. Charcoal filters in the first bank are replaced with filters from the second bank and new filters installed in the second bank. Used prefilters, HEPA filters, and charcoal filters will be incinerated in the Metal Parts Furnace.

The overall ventilation system will be balanced initially to provide the air changes required throughout the CAMDS operation. Filter performance including airflows will be monitored daily by QC. The total ventilation system will also be verified yearly or at a major system changeover.

d. Safety. Replacement of potentially contaminated filter components will be accomplished by personnel in level A protective clothing using "hot line" procedures. Replacement will be a very infrequent task and the hot lines will be established as required. The replacement procedures will be detailed in operational SOPs. The 333 CFM and 2000 CFM filter units employ the "bag in/bag out" concept in which the filters can be replaced from outside of the filter unit and polymer bags completely isolate the filters and interior of the filter housing during the replacement procedure. In the larger filter units, personnel must wear level A protective clothing to enter the filter housing, remove the used filters and seal them in polymer bags before removing them from the filter housing. All used filters will be stored in sealed bags in a ventilated portion of the Bulk Item Facility and eventually sent to the Metal Parts Furnace for disposal.

A motor disconnect switch is provided at each filter unit to enable maintenance personnel to insure that the blower cannot be started while maintenance is being accomplished.

All filter units which serve negative pressure toxic enclosures are provided emergency electrical power to insure containment of contamination in the event of loss of commercial power.

e. References.

(1) Report, C. A. Burchsted and A. B. Fuller, "Design, Construction and Testing of High-Efficiency Air Filtration Systems for Nuclear Applications, " Oak Ridge National Laboratory, January 1970. An engineering handbook used as the basis for the design of the CAMDS ventilation and filter systems. One of the authors, C. A. Burchsted, served as consultant to the CAMDS program.

(2) Standard, AACC STD CS-8, American Association for Contamination Control. Standard used for specification of charcoal filters.

(3) Standard, AACC STD CS-1, American Association for Contamination Control. Standard used for specification of high-efficiency particulate air filters.

(4) DF, SAREA-TS-C (M. Miller), "Agent Testing of Edgewood Arsenal and Commercial Filter Units", 3 Jan 74. A summary of testing and performance evaluation on 5 Farr (tray type) filters and 5 CBR XC10-1 filters that were subjected to GB vapors. See Incl 14.

(5) DF, SAREA-PL-S (Phil Robinson), "Additional Testing of Farr Filter Units", 10 May 1974. A summary of GB test data on AACC STD CS-8 charcoal filters manufactured by Farr Co. See Incl 14.

(6) DF, SAREA-TS-C (Paul Wagner), "VX Tests of Farr Filters", 5 Jun 1975. A summary of VX test data on AACC STD CS-8 charcoal filters manufactured by Farr Co. See Incl 14.

4-21 PERSONNEL SUPPORT COMPLEX (PSC), SITE MEDICAL FACILITY & DPE DRESS STATION

a. Purpose. The Personnel Support Complex provides personal and sanitary facilities for a 150 man labor force. The PSC serves as a change house and lunch room. It contains toilet and shower facilities. The PSC also provides ventilated areas for the handling and storage of protective clothing.

b. Description. The Personnel Support Complex consists of eight modules. The eight modules shown in Figure 4-43 are:

3 Locker Modules (#1, #2 and #4)
1 Clothing Storage/Toilet Module (#3)
1 Lunchroom (#8)
2 Change/Shower Modules (#5 and #6)
1 Protective Clothing Storage/Change Module (#7)

In addition to the eight trailers of the Personnel Support Complex shown in Figure 4-43, a separate trailer is located beside Module #7 to service the new demilitarization protective ensemble (DPE). This dress module contains all the necessary equipment to dress the worker in the DPE for entry into toxic areas. It houses a radio frequency heat sealer for sealing the worker in the disposable outergarment, a leak detector for checking the integrity of the final seal, and assorted test equipment for checking respirators and communications equipment.

A site medical facility is also located adjacent to the Personnel Support Complex and provides emergency medical treatment for the CAMDS staff. This medical facility consists of three areas; a decon and shower area, an emergency room and standby quarters. The emergency room has a capacity for four beds. A layout of the site medical facility and details of operation are contained in Inclosure 19, Medical Support Plan.

c. Operation.

(1) Shift change.

(a) Personnel reporting for work receive clean work clothes from the attendant in Module #3 and change from street clothing into work clothing in either Module #1, #2 or #4. The street clothing is stored in personnel lockers in these modules. After depositing lunch container in Module #8, personnel move to Module #5 or #6, don safety shoes and proceed on to work area. At the end of the shift, personnel enter the complex by Module #5 or #6. Shoes are stored and soiled clothing deposited in provided containers prior to the personnel taking showers. After showering, personnel return to locker Modules #1, #2 and #4 and dress in street clothing. Workers exit the plant through Module #3.

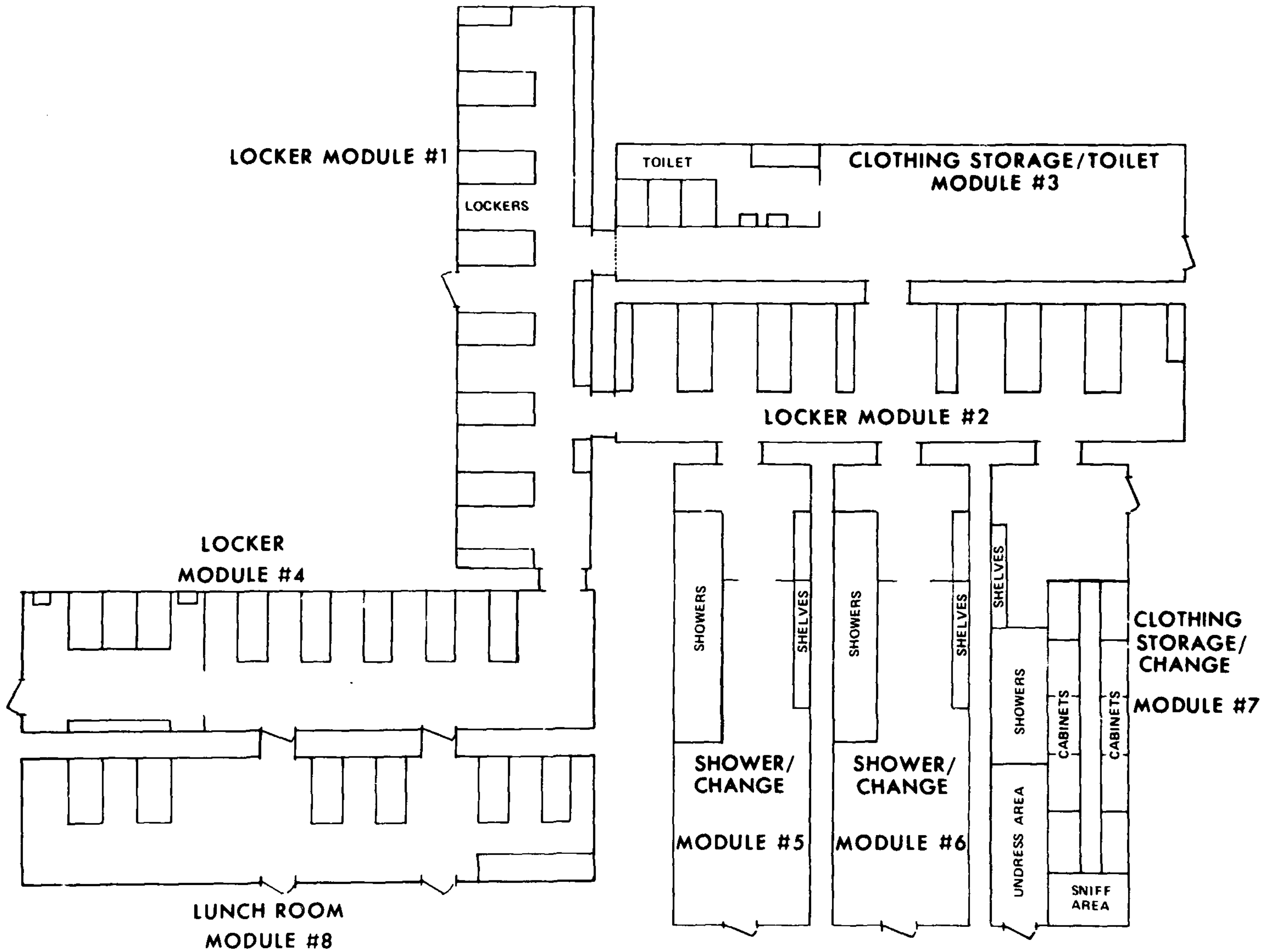


FIGURE 4-43 FLOOR PLAN Or THE PERSONNEL SUPPORT COMPLEX

(b) Personnel required to dress in level A protective clothing will be issued the necessary items of equipment in Module #7 or the Dress Module. Personnel performing surveillance operations or emergency operations will normally wear the M3 protective suit and dress in Module #7. Other operations requiring routine entry into toxic areas will be performed by personnel wearing the new DPE. Personnel will don the DPE in the DPE dress module. All personnel will be transported to their work areas in a specially designed transporter described in paragraph (3). In all cases where level A protection is used, the buddy system will be in effect and an emergency standby worker will be immediately available.

(c) When an individual wearing the M3 protective suit completes his assigned task, he will be decontaminated and undress following standard "hotline" procedures (if work was performed outside the toxic cubicles). He will remain masked during transport back to Module #7 for showering. Personnel wearing the DPE or the M3 in a toxic area will be decontaminated prior to entering the airlock. This will be accomplished by swabbing the protective clothing with a suitable decon solution. Particular attention will be given to the boots and gloves to insure thorough decontamination. The worker will enter the airlock and receive a deluge shower, after which he will be monitored with an M8 alarm. If contamination is detected, the worker will continue to shower until the M8 alarm has indicated the absence of contamination. The worker will undress, assisted by his co-worker. The DPE outergarment and gloves will be placed in plastic bags for disposal in the MPF. The boots will be bagged and monitored with the M8/Concentrator. The boots will be free of detectable amounts of contamination prior to being processed in the laundry. In the case of the rubber protective clothing, if the sniff test is negative, i.e., no detectable amount of contamination, the bag will be conveyed to the laundry for washing and inspection of the suit.

(d) After removing protective clothing, and with his mask still on, the worker will board the van for return to Module #7. The worker enters Module #7 through the rear door. If he was wearing a rubber suit, he will still be wearing a mask. He will undress except for his mask. Just prior to entering the shower, the worker takes a deep breath and unmasks. If a worker was wearing the disposable ensemble, he will remove his respirator and then take a shower. After showering, the worker will move to the locker module and dress in his street clothes or normal work clothes.

(2) Lunch and break periods.

(a) Personnel not in protective clothing enter Module #4 through the entrance into the toilet area. All personnel will wash hands prior to eating. At the end of the lunch or break period, lunch containers are returned to storage shelves in Module #4. Workers return to their work areas through any door in Module #4.

(b) Personnel who have been in protective clothing enter Module #7 into the undress area where they undress and shower. After drying off, workers don coveralls and shower shoes and move to Module #4 for lunch or break periods. At the end of the break period, the workers reshelve their

lunch containers and draw fresh underwear. If a worker is to return to work in protective clothing, he will return to Module #7, draw protective clothing from the attendant and dress. Exit to work will be via side door of Module #7. If worker is not required to return to work area in protective clothing, he moves to Module #5 or #6 and secures safety shoes and mask. After dressing and storing shower shoes, he will exit to the work area through end doors of Module #5 or #6.

(3) Use of personnel transporter vehicle. A personnel transporter will be used to convey personnel between the Personnel Support Complex (or the DPE dress module for the demilitarization protective ensemble) and toxic work areas which require level A protection. The driver of the transporter is in level E clothing. The transporter is a totally enclosed vehicle which is compatible with either the demilitarization protective ensemble (DPE) or the M3 protective suit. The transporter will provide compressed air for the DPE to and from the work area. An overhead covering is provided at each air lock exit door so that protection is provided to personnel entering and leaving the van. Workers exiting the toxic work areas will continue to wear their respiratory protection in the transporter to the PSC to protect them from possible minimal residual contamination on their person. The transporter is sized to carry up to four suited workers. It is custom fabricated from a 3/4 ton pickup camper shell. The interior of the shell is totally enclosed and is painted with agent impermeable epoxy paint. Floor drains are provided to facilitate decontamination/cleaning. The floor drain contains a valve which would be used to drain the transporter after it has been decontaminated. The effluent from the washdown is drained to one of the toxic sumps from which it is pumped to the Agent Destruction System waste neutralization tank to be processed. Lighting, driver-passenger intercom system and life support air bottles are installed within the shell. The shell is fitted with a breathable panel fabricated of gas/aerosol filter laminate material and an induced draft ventilation duct to permit air to enter the sealed transporter. Once the transporter reaches the Personnel Support Complex, it will be ventilated by the PSC filter unit.

(4) Site medical facility. A casualty is brought into the decon and shower room where he is monitored using an M8 detector. Clothing will be removed as required for treatment and the casualty will be showered. The casualty will be monitored again and then taken into the emergency room for treatment. After treatment is completed, the patient will be moved by ambulance either to the north area hospital or to a Salt Lake City hospital. There will be one ambulance at the medical facility's ambulance garage at all times. The standby quarters are utilized by the emergency health technicians who are stationed at the site around the clock.

d. <u>Safety.</u> Module #7 is ventilated and the exhaust air is passed through a CAMDS filter unit.

4-22 UTILITIES HOUSING (UTL)

a. Purpose. The purpose of the Utilities Housing is to provide an enclosed area for the boiler plant, compressed air supply system and the 480-volt emergency electrical generator system.

b. Description. The Utilities Housing is located between the Projectile Disassembly Facility and the perimeter fence. The following utilities are located within the housing (see Figure 4-44).

boiler controls
boiler #1 (600 hp)
boiler #2 (600 hp)
air compressor #1
air compressor #2
emergency generator control panel
emergency generator (480 volt)

(1) Boiler plant. The boiler plant consists of an oil-fired, two boiler, steam generating system which supplies steam to the following areas:

Agent Destruction System
Metal Parts Furnace System
Deactivation Furnace System
Dunnage Incinerator
Unpack Area
Bulk Item Facility
Explosive Containment Cubicle Housing
Explosive Containment Cubicle Hydraulics Housing
Explosive Treatment System
Projectile Disassembly Facility

Boilers are designed to operate at a pressure of at least 225 psig. Each boiler is a complete high pressure horizontal packaged fire tube boiler with an operating rating of 600 boiler horsepower. Steam pressure should not exceed 150 psig during normal operation. Boilers are fully modulated with at least a four to one turn-down ratio. Each boiler is capable of burning either number two or number six grade fuel oil.

A water treatment system provides softened water of a quality that is acceptable for boiler plant operation. The feedwater temperature is approximately 200°F. The fuel to steam efficiency is 80 percent minimum over the entire operating range.

(2) Compressed air supply system. The compressed air supply system consits of two air compressors capable of delivering a minimum of 95 cubic ft/min at 100 psig to the following areas:

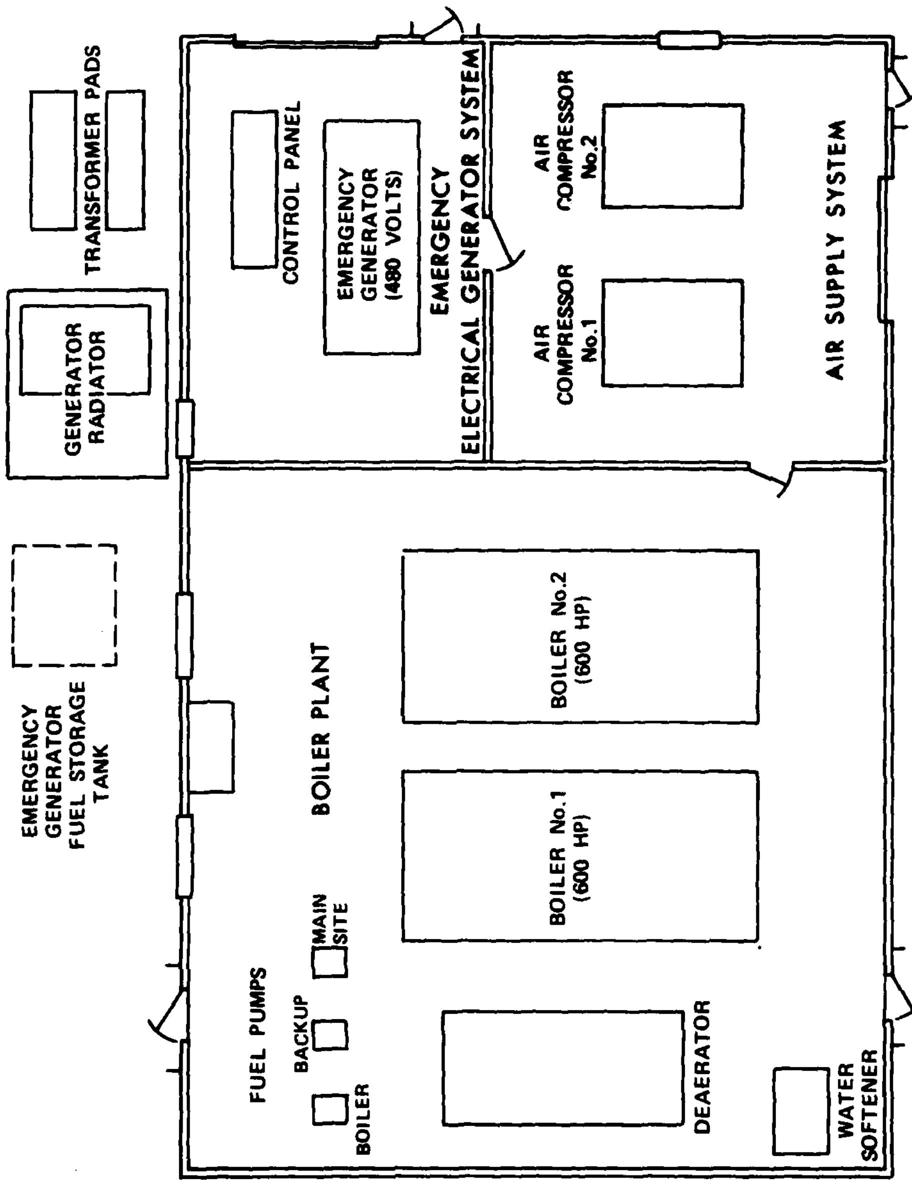


FIGURE 4-44 UTILITIES HOUSING LAYOUT

Agent Destruction System
Metal Parts Furnace System
Deactivation Furnace System
Unpack Area
Bulk Item Facility
Explosive Containment Cubicle Housing
Explosive Containment Cubicle Hydraulics Housing
Explosive Treatment System
Projectile Disassembly Facility

Compressors are designed to operate at an altitude of 5500 feet above sea level with an inlet air temperature between 20°F and 110°F. The compressor system is equipped with dessicant dryers. Compressed air leaving receiver tanks will have a maximum pressure dewpoint of -20°F. Each compressor is equipped with a steel air receiver tank capable of holding 300 standard cubic feet of air at 95 psig minimum.

(3) 480-volt emergency electrical generator system. This system is actually considered part of the Electrical Distribution System and is covered in Section 3-25.

c. Operation. The boiler plant and compressed air supply system are locally operated, but are monitored by the CAMDS computer. The emergency generator system operation is covered in Section 3-25.

d. Safety. All electrical components, including motors, dryers and all wiring are approved by UL or an equivalent testing laboratory. The compressor system is in accordance with applicable OSHA requirements for plant process air. Sound level at a maximum distance of 10 feet from the compressors will not exceed 85 decibels. Compressors are wired to allow independent operation of either compressor.

Boiler controls are equipped with alarm systems for low water, high stack temperature and high steam pressure. These conditions will be monitored by the central Computer Control System as well as at the boiler system control panel. Fuel burning equipment conforms to Section VI of the ASME Boiler and Pressure Vessel Code. The boiler system meets applicable OSHA requirements. Sound level of the boiler system when operating will not exceed 85 decibels (A scale), steady state noise, when measured at a maximum distance of 10 feet from any portion of the system.

A dike will be placed around three fuel storage tanks which provide fuel oil to the boiler plant. The dike will be sufficient to hold at least 110 percent of the capacity of one tank.

e. Reference. Boiler and compressor specifications are contained in Inclosure 18.

4-23 CLOSED CIRCUIT TELEVISION SYSTEM (CTV)

a. Purpose. The CTV is used to remotely monitor all critical operations in hazardous or unmanned areas.

b. Description. The CTV consists of eleven television cameras, 9-inch monitors and two 23-inch monitors. The cameras are all remotely controlled. Eight of the cameras are equipped with remote controlled zoom lenses and pan and tilt mounts. Two of the cameras have fixed mounts and fixed lenses. The locations of the cameras and monitors are listed below.

(1) Unpack Area. One camera with zoom, pan and tilt. The controls and monitor for this camera are in the control module.

(2) Explosive Containment Cubicle (ECC). One fixed camera and one camera with zoom, pan and tilt. The controls and monitors for both of these cameras are in the control module.

(3) ECC Housing. One camera with zoom, pan and tilt in the segregator conveyor area of the ECC housing. The controls and monitor for this camera are in the control module.

(4) Deactivation Furnace. One camera, with zoom, pan and tilt located at the end of the furnace dishcarge conveyor. The controls and monitor for this camera are in the control module.

(5) Projectile Disassembly Facility. Two cameras with zoom, pan, and tilt to monitor the projectile pull and drain operations. The controls and monitors for these cameras are located in the control module.

(6) Agent Destruction System (ADS). Three cameras with zoom, pan, and tilt located in and above the toxic cubicle pit area. The controls and monitors for these cameras are mounted on the control panel in the ADS.

(7) Metal Parts Furnace (MPF). One fixed camera will be located in the punch chamber of the furnace. The need for additional cameras will be determined during shakedown tests of the MPF. The controls and monitor for the MPF cameras are installed in the control panels at two control stations in the MPF housing.

c. Operation. The two 23-inch monitors are installed in the administration area of the control module. Video switches allow the CAMDS supervisors to select the picture from any of the cameras.

The remote controls for the zoom lenses allow the operator to select a close-up view of a small area or a more distant view of a larger area and to adjust the focus and iris of the lens. The pan and tilt mount remote controls allow the operator to move the camera to view any portion of the area where the camera is located. The remote controls for the camera allow the operator to adjust the camera focus, the camera signal level and to turn the camera on or off.

The monitors contain all the controls normally found on commercial TV sets. The horizontal hold and width and the vertical height and linearity controls, normally on the back of commercial TV sets, are on the front of the monitors.

The CTV has a central synchronization generator in the control module. This allows the operators to switch a monitor from one camera to another without losing synchronization.

d. Safety. Forced air cooling is applied to the camera inclosures located in high temperature areas. Non-metallic (plastic) camera inclosures are used with cameras subjected to caustic liquids or fumes. The TV system allows continuous surveillance of maintenance personnel working in contaminated areas. TV cameras and equipment used in the Unpack Area, the ECC and the ECC housing are in Class I enclosures and will, therefore, satisfy NEC requirements.

4-24 COMMUNICATION SYSTEM (COM)

a. Purpose. The COM provides dedicated communication between all control stations and housings on the CAMDS site. It also provides direct communication between supervisory personnel at control stations and maintenance personnel wearing level A protective clothing in contaminated areas. A public address paging system is provided to all locations on the CAMDS site.

b. Description. This system consists of a central exchange with capabilities of handling 50 phone extensions and an amplified public address speaker system and a separate speaker phone intercom system for communications between the control room and personnel in the Demilitarization Protective Ensemble (DPE) in toxic areas. The central exchange and the amplifiers for the public address speakers are located in a separate housing adjacent to the emergency power rail car.

Each extension phone utilizes push button dialing and contains a common line switch and a jack to plug in a head set with an extension cord. A priority interrupt system is incorporated into the central exchange so a third party can break into a connection between two other parties in an emergency situation. Phone extension in outdoor or high noise level locations are installed in weather/noise proof booths and are equipped with a horn instead of a buzzer.

The separate speaker phone intercom system for DPE communications provides 24 channels with a two-way call capability. An interface box provides direct connection with the communications system in the DPE.

c. Operation. Each telephone extension number consists of two digits. Calls from one station to another are made as with any phone system. The priority interrupt system allows a third party to break in on a busy line by simply clicking his receiver one time. The presence of a light background busy signal will warn the parties interrupted that a third party is on the line.

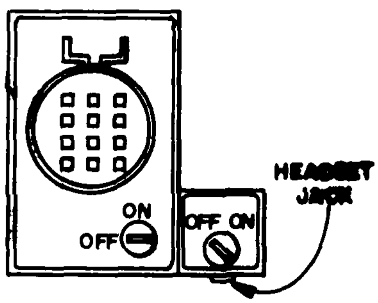
The common line feature of the system allows conference connection of more than three parties. No dialing is required. All parties involved turn a common line switch on the front of the phone to the on position. The common line is battery powered and will accommodate six phones without serious signal attenuation. The common line switch must be turned back to the off position to place the phone back into normal service.

Head sets with long extension cords are used when an operator or maintenance man requires communication but must be free to move about or use his hands. A switch adjacent to the head set jack connects and disconnects the hand set and head set. The head set switch must be turned off when not in use or the phone will react as a busy line.

Table 4-5 is the CAMDS site phone directory. Dialing number 11 from any phone will allow public adress (paging) throughout the total CAMDS site. There are also separate public address systems for the Agent Destruction System housing and the Metal Parts Furnace housing.

TABLE 4-5
CAMDS SITE TELEPHONE DIRECTORY

AREA LOCATION	EXTENSION
Agent Destruction System	40, 47, 48, 49
Bulk Item Facility	44
Control Module	28, 29, 30
Control Point	22, 23, 24, 25, 26, 27
Deactivation Furnace	37
Deactivation Furnace Scrubber	38
Dunnage Incinerator	36
Explosive Containment Cubicle	Not assigned
Explosive Containment Cubicle Building	13
Emergency Generator Car	10
Explosive Treatment System	39
Guard House	15
Metal Parts Furnace	Not assigned
Munition Holding Area	18
Paging Intercom - Agent Destruction System	Not assigned
Paging Intercom - Metal Parts Furnace	Not assigned
Paging Intercom - Site Area	11
Personnel Support Facilities	32, 33
Projectile Disassembly Facility	42, 43
Utilities Housing	46
Utilities Module	17
Unpack Area	14
Power Distribution Module	19
Parts Building	12



INSTRUCTIONS

__Conference Line__. Turn common line switch to on position.

__Priority Interrupt__. A third party may interrupt a busy line by clicking receiver once.

__Both Common Line and Headset Switch Must Be In The Off Position When Not In Use__

d. Safety. The Communication System is on the emergency power supply so communications will not be lost in case of commercial power failure.

4-25 ELECTRICAL DISTRIBUTION SYSTEM (ELE)

a. Purpose. The purpose of the electrical distribution system is to supply and distribute commercial and emergency standby power throughout the CAMDS site.

b. Description. Electrical power to the CAMDS site is supplied by 12,470 volt feeder lines from the Ophir substation of the Utah Power and Light Co. located 7-1/2 miles away. The CAMDS site contains four power transformers: a 75 KVA 208 volt unit for the well pump; a 300 KVA 208 volt unit for the Personnel Support Complex; a 750 KVA 208 volt and a 1500 KVA 480 volt unit for the demil equipment.

The secondary power from the transformers is connected to six motor control centers and from there distributed to the various loads. The power cables between the transformers, the motor control centers and the CAMDS housings are supported in cable trays. Table 4-6 lists the normal power requirements for each portion of the CAMDS site.

The CAMDS site also has three diesel engine driven emergency standby generator sets to supply power to critical areas in case of a commercial power failure. One 500 KW unit supplies 480 volts and two 235 KW units supply 208 volts. Table 4-7 lists the emergency power requirements for the CAMDS site.

c. Operation. Commercial power is the normal power source for the CAMDS site. The failure of commercial power is sensed by an automatic transfer switch which starts the emergency generators and switches critical loads to the standby power. The emergency power can be on line 10 seconds after a power failure. Only one of the 208-volt generators is started. If the first one fails to start, the second one is activated.

Demil production operations will terminate when a power failure occurs. The standby power is supplied only to those systems such as the control, communication, TV, filter, scrubber and emergency light systems required to maintain a safe condition. Some critical equipment in the Agent Destruction, Metal Parts Furnace and Deactivation Furnace Systems is connected to the emergency power in order to complete demil operations already in process and permit a safe and orderly shutdown.

d. Safety. All electrical fixtures conform to applicable NEMA standards and all installations conform to the National Electrical Code. Equipment and installations involving special hazard class requirements meet the requirements dictated by the nature of the environment. All critical process functions are provided with standby power. The emergency generators will be tested periodically to assure proper operation.

TABLE 4-6
CAMDS ELECTRICAL POWER REQUIREMENTS (KVA)

	TOTAL LOAD CONNECTED	MINIMUM LOAD	PEAK LOAD	AVERAGE LOAD
Unpack Area	10.9	0.0	2.2	2.0
Explosive Containment Cubicle	2.0	0.0	1.0	1.0
Deactivation Furnace System	391.0	40.0	333.0	250.0
Metal Parts Furnace System	413.0	186.0	295.0	255.0
Dunnage Incinerator	18.0	0.0	11.0	8.0
Utilities	225.0	70.0	140.0	105.0
ECC Hydraulic System	9.0	0.0	8.3	6.3
Control Center	25.2	0.0	25.2	21.2
Personnel Support Complex	119.2	0.0	119.0	90.0
Agent Destruction System	647.0	125.0	460.0	345.0
Explosive Treatment System	12.8	0.0	9.3	9.3
Projectile Demil Machine	5.0	0.0	6.0	6.0
Projectile Pull & Drain	24.5	0.0	15.0	15.0
Central Decon System	8.5	3.5	4.5	4.5
Projectile Disassembly Facility	3.0	0.0	3.0	2.0
Material Handling Equipment	10.6	6.0	8.0	7.0
Filter System	122.0	100.0	122.0	92.0
Piping	20.0	0.0	20.0	15.0
Electrical	59.0	0.0	59.0	59.0
Perimeter Monitoring	96.0	8.0	48.0	42.0
Closed Circuit Television	2.0	1.0	2.0	2.0
Communications	1.2	0.0	1.2	1.0
Detectors	10.0	10.0	10.0	10.0
Site Control System	15.0	0.0	8.6	8.6
Boilers	135.0	30.0	60.0	50.0
Others	50.0	0.0	23.5	13.5
Total	2299.7	549.5	1734.8	1361.8

TABLE 4-7

CAMDS EMERGENCY POWER REQUIREMENTS (KVA)

	208 VOLT	480 VOLT
Deactivation Furnace System		90.0
Metal Parts Furnace System		100.0
Utilities		158.0
Control Center	12.6	
Agent Destruction System		258.0
Bulk Item Facility	3.0	
Filter System	100.0	
Electrical	36.5	
Closed Circuit Television	2.0	
Communication	1.2	
Site Control System	8.6	
Total	163.9	606.0

e. <u>References</u>.

(1) National Electrical Code.

(2) National Electical Manufacturers Association (NEMA) Standards.

(3) Army Materiel Command Regulation (AMCR) 385-100, Safety Manual, April 1970 with Ch 2, 12 Sep 1974.

4-26 PIPING (PIP)

a. Purpose. The piping system conveys air, steam, water, agent (GB and VX), decon solutions (sodium hydroxide, calcium hypochlorite, sodium carbonate), hydraulic fluid, scrubber brine and fuel oil within the CAMDS site.

b. Description. All piping, except main water and fuel oil which are underground, is installed above ground supported with pipe racks. Agent lines and exposed water lines are heat traced with electric heating tape to prevent freezing. Decon solution lines are heat traced with steam lines to prevent freezing. The decon solution lines are fabricated from polypropylene lined steel pipe. All other piping is carbon steel.

All agent lines are double walled pipe with the agent in the inner pipe and with the annular space between the pipes under negative air pressure and monitored with agent detectors. The agent lines are all butt welded with gasket flanges at machine interfaces. The welds are all inspected using radiographic techniques. The agent lines are all hydrostatically pressure tested and then leak tested using freon.

c. Safety. All agent lines are installed with a slope of at least 1/8 inch per foot. The air evacuated from the outer pipe of the agent lines is continuously monitored with an M8 detector which has a sensitivity action level of 0.2 mg/m^3 for agent GB. When an alarm occurs, agent transfer operations will be suspended and the leak traced and corrected. Sample ports are provided in the outer pipe every 15 feet to facilitate fault location. The air from the outer pipe is exhausted to the toxic area of the Agent Destruction System (ADS) and then through the ADS charcoal filter system. All lines are color coded and identified to indicate their contents and direction of flow in accordance with applicable Army regulations. Areas under overhead pipe racks are posted as restricted areas and will be maintained free of personnel. Vehicle height restrictions are enforced at the entry gate. Special work permits are required for vehicles exceeding the height restrictions, such as cranes. Pipe racks at road crossings have a high strength structural crossbeam, protecting it from either end.

4-27 DETECTORS (DET)

a. Purpose. A system of detectors will be employed by CAMDS to verify compliance with all applicable gaseous stack emission and working area standards, to provide rapid warning of hazardous conditions, to monitor agent contamination levels in toxic process areas and to check protective clothing of personnel leaving toxic areas for adequacy of decontamination. Applicable stack emission and working area standards are shown in Table 4-8 and are discussed in Inclosure 1.

TABLE 4-8

MAXIMUM EMISSIONS & WORKING AREA STANDARDS

	Maximum Emissions*	Maximum Control Value for Unmasked Workers**
GB	0.0003 mg/m^3	0.0001 mg/m^3
VX	0.00003 mg/m^3	0.00001 mg/m^3
HD	0.03 mg/m^3	0.003 mg/m^3
SO_2	500 ppm	

*Based on 1 hour sample time

**8 hours per day for an indefinite period averaged over not more than 10 consecutive work periods for GB or 5 consecutive work periods for VX or H.

b. Description. The CAMDS agent detectors must perform two primary functions: they must give immediate warning of hazardous situations, and they must measure low level concentrations of agent (stack emission and working area standards) to guard against cumulative effects over an extended period of time. To meet these requirements, a system of dual detectors is used. An automatic detector with fast response time is used to warn of hazardous situations. A bubbler absorption system is used to collect a sample which is analyzed in the laboratory for low level agent concentrations.

The following detectors were found suitable for CAMDS use. The sensitivities and response times of the agent detectors are shown in Table 4-9. A detailed description of nerve agent alarms and detectors is contained in Inclosure 13.

TABLE 4-9

SENSITIVITY AND RESPONSE TIME OF CAMDS DETECTORS

GB Detectors	Sensitivity (mg/m^3)	Response Time
M8 Alarm	0.2	1 min
M5 Alarm	0.2	1 min
M8/Concentrator	0.2	1 min
	0.001	33 min
Bubblers	0.0001	2 hrs
	0.000003	13 hrs
Real Time Monitor	0.0001	10 min
VX Detectors		
M8 Alarm	0.4	3 min
M5 Alarm	0.4	3 min
Bubblers	0.00001	2 hrs
	0.0000003	13 hrs
Real Time Monitor	0.00001	10 min
Mustard Detectors		
Tracor GC (RMA Instruments)	0.3	8 min
Tracor GC/Sulfur Analyzer	0.3	8 min
Titrilog III	0.3	5 min
Bubblers	0.003	2 hrs
Real Time Monitor	0.003	60 min

(1) M5 detector. A semi-portable automatic alarm for detection of G and V agents (a fluorinating filter must be used to detect V agents). The agent is absorbed and reacted with reagents contained in the detector, exposed to ultraviolet light, and the resulting fluorescence measured by a photomultiplier tube. The developed signal is directed to a recorder and an alarm.

(2) M8 detector. A portable automatic alarm for detection of G and V agents (a fluorinating filter must be used to detect V agents). The reaction of agent with the reagents in the detector are electro-chemically monitored to detect the agent. The detector will operate on 115 volts or batteries.

(3) M8 detector with concentrator. A monitor system capable of automatic detection of low concentrations of GB agent. The system utilizes the standardized M8 alarm as the detection principle which is augmented by a concentrator device to lower the agent levels which can be detected. A detailed description of the M8 with concentrator is contained in Inclosure 13.

(4) Real time monitor. A detector capable of monitoring low chemical agent concentrations automatically with a 60 minute or less response time. These detectors alarm when agent concentrations exceed the levels established by the US Surgeon General. There are two separate instruments, a nerve agent (G and V agents) real time monitor and a mustard agent real time monitor. The nerve agent real time monitor scrubs any agent from the sampled air and reacts it with eel enzyme. The enzyme inhibition is measured colormetrically to determine the concentration of agent in the sampled air. The mustard agent real time stack monitor directs the sampled air through a gas chromatographic column to separate the mustard agent. The gas stream is then passed through a flame photometric detector specific for sulfur to detect and measure the mustard agent concentration. The nerve agent real time monitors were initially installed in CAMDS in April 1977. They will be operated concurrently with M8 alarms and M8/concentrators to verify their reliability over extended periods in a plant environment. Mustard monitors will be available in 1980. A detailed description of the real time monitor is contained in Inclosure 13.

(5) Tracor gas chromatograph. A fixed point alarm for the detection of mustard. The instrument uses a chromatograph column and a flame photometric detector specific for sulfur to detect the presence of mustard. The alarm circuits are programmed to monitor the detector output at the characteristic elution time of mustard.

(6) Titrilog III. A commercially manufactured instrument for the detection of sulfur and reducing agents. Bromine titration is used to colormetrically measure the quantity of the reducing agent (in this case, mustard). The instrument is subject to interference from reducing and oxidizing agents.

(7) Bubbler absorption system. These agent sampling systems for G, V and mustard agents, bubble air through a suitable absorbing solution at a known rate for a known period of time. The sample is then analyzed in the laboratory for the particular agent being demilitarized. With one to two hours sampling time, this method of detection will satisfy the agent sensitivity requirements for stacks and working areas.

(8) SO_2 analyzer. A commercially available sulfur dioxide analyzer is used to automatically monitor and record SO_2 levels.

The CAMDS detector systems will incorporate any new developments in detection capability as they become available. The CAMDS operation is predicated on the use of the most effective agent detectors and alarms in existence and it will serve as a proving ground for improved systems. Thus, operations will be started with M8 detectors and M8 detectors with concentrators while real time monitors are being obtained and proven in the plant. It is anticipated that the real time monitor will provide the higher sensitivity required for the working area with a response time of 10 minutes or less for nerve agents.

c. <u>Operation.</u> The current CAMDS detector plan is shown in Table 4-10. These detectors operate continuously with routine periodic maintenance. Normally uncontaminated work areas in CAMDS which are ventilated at six air changes per hour are continuously monitored to warn against unexpected or accidental contamination. An automatic detector with fast response time is used to warn of acute contamination conditions. When processing either GB or VX, an M8 with concentrator or real time monitor (when it becomes available) is used. The Titrilog II or SO_2 analyzer is used when processing mustard agent. In addition, a bubbler absorption system is used when processing GB, VX or mustard to determine low level concentration. Bubbler data will be maintained to provide a record of agent concentration time (Ct) values in the various CAMDS areas.

M8 alarms will be used in toxic process areas to monitor the presence of agent and indicate process upsets. Any detection of agent would indicate a process upset. The M8 was selected because of its fast response time.

Detector locations are shown in Figure 4-45. Table 4-11 summarizes detector requirements. Routine maintenance includes replenishing reagent supplies, calibration of airflow, checking functioning of alarms, and preventative maintenance as given in the instrument's operating manual. The bubbler absorption systems require calibration of airflows, checking bath temperatures, replacing used bubblers with fresh ones, and returning used bubblers to the laboratory for analysis.

Operators are trained in normal operating procedure for all the instruments used in the detector system. Training also includes trouble-shooting procedures, calibration methods, and proper handling of any alarm conditions.

Temperature controlled rooms are provided to house instruments and stack effluent agent monitoring equipment at the Deactivation Furnace System and the Metal Parts Furnace stacks. The monitoring stations are provided with all necessary supporting utilities. Air pollution monitoring equipment housed in the stations includes: SO_2 monitor, continuous O_2 monitor, and chemical agent monitoring equipment. Each system is comprised of three main functional groups: the sample probe and transfer line including sample pump and filters, the analyzer/recorder instruments and the alarm circuitry.

Sampling probes are used to draw samples of gases from the stack. These gases are transferred by sample pumps to the analytical instruments. The instruments perform the analyses and record the results. If any result exceeds a set point limit, an alarm will sound and corrective measures will be taken.

TABLE 4-10

CAMDS DETECTOR PLAN

Area	GB & VX Detector	Mustard Detector
Stack Monitors (DFS & MPF)	M5 Alarm Bubblers Real Time Monitor	Tracor GC SO_2 Analyzer Real Time Monitor
Stack Monitors (Filter stacks)	M8 Bubblers	Titrilog III SO_2 Analyzer Bubblers
ADS Dryer Stack Monitoring	Bubblers*	Bubblers*
Work Area Monitors	M8/Concentrator Bubblers Real Time Monitor	Titrilog III SO_2 Analyzer Bubblers
Toxic Process Monitors	M8 Alarm	Not Applicable
Clothing Sniffer Monitors	M8 Alarm	Not Applicable

*There are no known automatic detection systems presently capable of monitoring the dryer stack. Present techniques employ bubblers to determine emission levels.

Temporary bubblers will be used during system integration and for periodic spot checks during operations to validate certification.

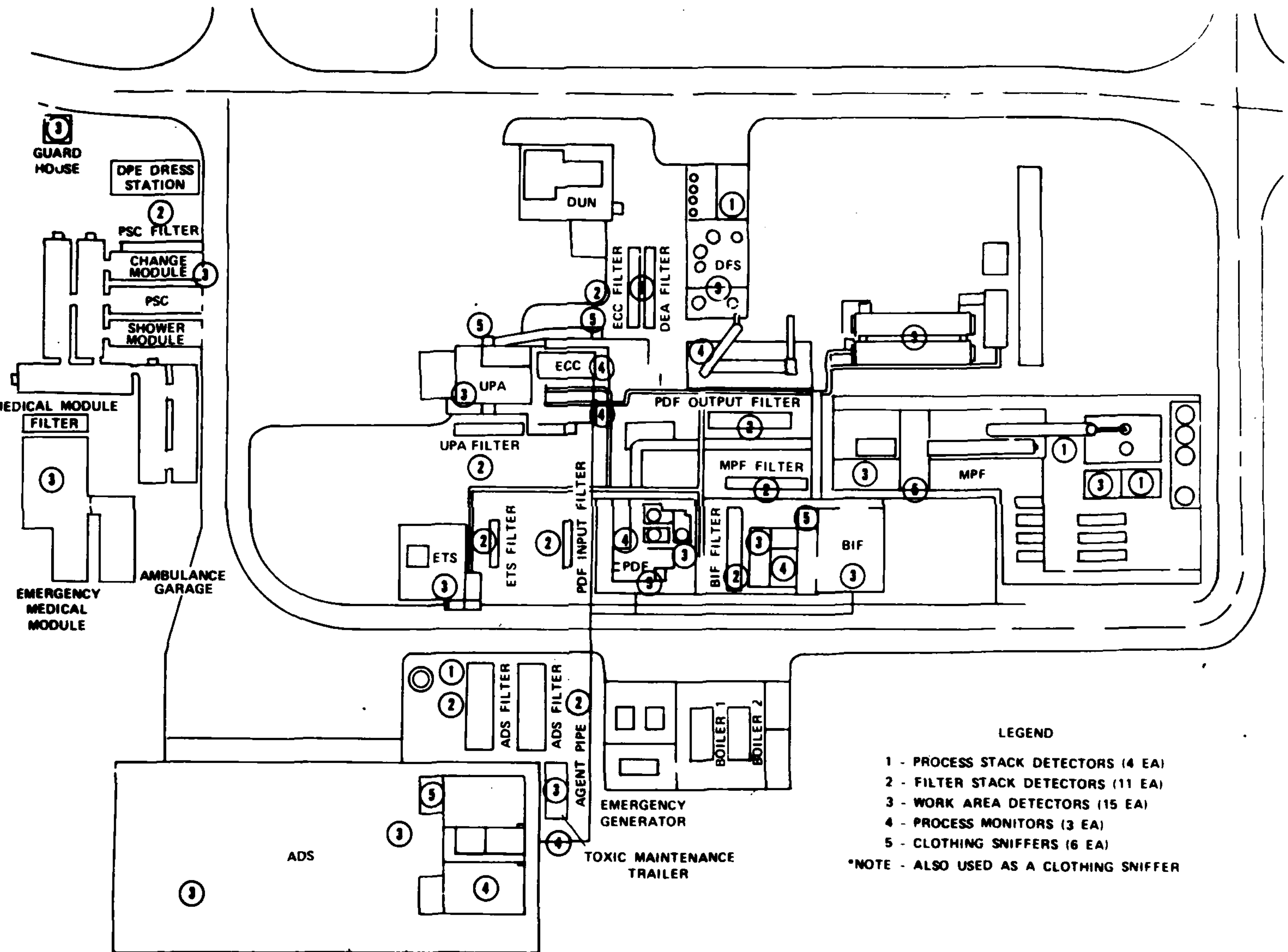


FIGURE 4-45 DETECTOR LOCATIONS

TABLE 4-11
DETECTOR REQUIREMENT SUMMARY
M55 Rocket (GB)

	AREA	LOCATION	PURPOSE	TYPE M10	TYPE DCAC	TYPE M5	TYPE BUBBLER STATION
1	UPA	Non-Toxic Area	Work Area		1		1
2	UPA	Toxic Shower	Suits; Temporary	1			(1)*
2a	UPA	Toxic Shower	Air in Shower				(1)
3	ECC	Inside of ECC	Temporary				(1)
4	ECC Housing (Segregator)	Glove port room	Temporary				(1)
5	ECC (Agt piping below ECC)	Glove port room					(1)
6	ECC Housing	Toxic Shower	Suits	1			
7	DFS	Scrubber Area	Work Area		(1)		
8	DFS	Effluent Stack	Stack			1	1
9	DFS	Afterburner Area	Temporary				(1)
10	MPF	Control Room	Work Area		1		1
11	MPF	Toxic Shower	Suits	1			
12	MPF	Furnace Exit	Work Area		1		1
13	MPF	Furnace Exit Hood	Stack			1	
14	MPF	Effluent Stack	Stack			1	1
15	MPF	Scrubber Area	Work Area		(1)		(1)
16	CMO	Control Room	Work Area				(8)
17	ADS	Dryer Area	Work Area		(1)		(8)
18	ADS	Control Room	Work Area		1		1
19	ADS	Toxic Cubicle	Toxic Cubicle; Temporary	1			(1)
20	ADS	Toxic Shower	Suits	1			
21	ADS	Toxic Cubicle	Process Piping	1			
22	ADS	Effluent Stack	Stack				(1)
23	PSC	Toxic Shower Area	Personnel		1		(8)
24	SMF	Medical Treatment Room	Work Area				(8)

*Parenthesis ( ) indicate a temporary detector.

TABLE 4-11
DETECTOR REQUIREMENT SUMMARY
M55 Rocket (GB)

	AREA	LOCATION	PURPOSE	TYPE			
				M10	DCAC	M5	BUBBLER STATION
27	Guard House	At Guard Station	Work Area				(8)
28	Toxic Maint Fac	Outside of Hood	Work Area		1		1
29	BIF	Holding Area	Bagged suit check		1		
30	BIF	Holding Area	Work Area		1		1
31	CML	Agent Lab Area	Work Area		1		1
32	Laundry	Undecided	Work Area				1
33	UPA	Filter	Filter	1			1
34	MPF	Filter	Filter	1			1
35	DFS	Filter	Filter	1			1
36	PSC	Filter	Filter	1			1
37	ADS	North Filter	Filter	1			1
38	ADS	South Filter	Filter	1			1
39	ECC	Filter	Filter	1			1
40	BIF	Filter	Filter	1			1
41	ETS	Filter	Filter	1			1
			TOTALS	15	9(3)	3	19 (14)

All agent detectors, except bubblers and clothing sniffer monitors, are continuously monitored by a status indicator panel in the Control Module (CMO). In the event agent is detected, the detector horn sounds in that area and a signal is instantaneously transmitted to the CMO which activates a horn and a light on the annunciator panel indicating which detector has been set off. The local alarm alerts the operators to mask and take proper action as outlined in the emergency SOPs. The alarm in the CMO alerts the shift engineer of agent release. The detector system is also interfaced with the CMO computer which provides a permanent record of the date, time and location of each alarm signal. Status panels are utilized to indicate which detectors are operational and a recorder to keep track of the output of each monitor. CAMDS agent detectors are all connected to an emergency power source to provide uninterrupted operation during power failure. In order to assure that each automatic alarm system (e.g., M8, M5, M8/Concentrator and real time monitor (RTM)) provides the needed monitoring sensitivity, each system will be challenged daily with a low concentration of agent, using a portable agent generator. Quality Inspection Specialists will check the overall operation of the monitoring system each day for compliance with applicable SOPs. To verify the accuracy of bubbler samples, control samples of various concentrations will also be analyzed daily. Records will be maintained containing the date and time and the reported laboratory value will be kept for each control sample. The present recovery will be calculated and control charts will be established.

d. Safety. When a detector is tested or calibrated using agent, the required safety procedures regarding containment, protective clothing and personnel limits are followed. The detectors will be isolated from the environment they are sampling, whenever possible, to avoid contamination of the detector during an alarm condition.

e. References.

(1) Edgewood Arsenal Special Report EASP 100-98 by B. P. McNamara and F. Leitnaker, "Toxicological Basis for Controlling Emission of GB into the Environment", March 1971. Establishes maximum allowable concentrations of GB for unmasked workers and for the general population. See Incl 4.

(2) Edgewood Arsenal Special Report EASP 1100-1 by B. P. McNamara, F. J. Vocci and F. C. Leitnaker, "Toxicological Basis for Controlling Emission of VX into the Environment", October 1971. Establishes maximum allowable concentrations of VX for unmasked workers and for the general population. See Incl 4.

(3) Edgewood Arsenal Special Publication EB-SP-74030 by B. P. McNamara, E. J. Owens, et al, "Toxicological Basis for Controlling Levels of Mustard in the Environment", June 1975. Establishes maximum allowable concentrations of mustard for unmasked workers and for the general population. See Incl 4.

(4) Edgewood Arsenal Technical Memorandum EATM 300-4 by H. R. Carlon, "Chemical Alarms and Detectors for Demilitarization, Storage and Transport Operations", July 1970. Outlines the capabilities and availability of existing chemical agent alarms and detectors including the M5 and M8. See Incl 13.

(5) Honeywell, Inc., final report ED-CR-73011 under Contract DAAA15-72-C-0335 by B. C. Schluter and W. E. Anderson, "Ionization Detector System", September 1973. Describes the development and initial field test results of the ionization detector.

(6) Honeywell, Inc., final report ED-CR-74025 under Contract DAAA15-73-C-0257 by B. C. Schluter, "Retrofitting of Ionization Detector Systems", October 1974. Summarizes the results of sensitivity tests using G & V agents.

(7) DF, SAREA-DE-DDA (Appel), "Agent Detector Plan for CAMDS", 13 June 1975. Outlines the plan for a complete detection system to satisfy CAMDS requirements.

4-28 PERIMETER MONITORING (PER)

a. Purpose. The Perimeter Monitoring network is designed to provide a positive check of the ambient air quality at the perimeter of the CAMDS demilitarization site. Sulfur dioxide, nitrogen dioxide, ozone, suspended particulates, wind speed and wind direction will be monitored as well as nerve agents (see Table 4-12).

Data collected by the Perimeter Monitoring network will provide a permanent record of ambient air quality with which to demonstrate compliance with air quality standards. Ambient air samples will also be analyzed for the anti-cholinesterase activity as an indication of nerve agent concentrations. Existing standards for nerve agents are also included in Table 4-12.

The Perimeter Monitoring network is not intended as a process control, and it is not connected on a real time basis to a central location. All CAMDS process controls and monitors will be at the demilitarization site.

b. Description. The Perimeter Monitoring network consists of eight identical sampling stations positioned around the perimeter of the demilitarization site. The sampling stations are portable trailers which have been semi-permanently installed. Each trailer is temperature controlled and provides all the housing necessary to protect the instrumentation from the environment.

The sampling network is approximately 4.75 miles in diameter with the stations located as indicated in Figure 4-46. A mathematical model to calculate downwind concentrations of pollutants released at the demilitarization site was developed and tested by Dugway Proving Ground using tracer particle releases at the demilitarization site.

Each station has instruments to measure wind speed, wind direction, ozone, sulfur dioxide, and nitrogen dioxide on a real time basis. The output signals from the five instruments are fed to a data logging system which conditions, averages, and prints the final output. The output will be a computer compatible punched paper tape and a printed hard copy. In addition to parameters measured on a real time basis, provisions are made to measure ambient concentrations of anti-cholinesterase agents and suspended particulates on a regular basis. Measurements of these two parameters require laboratory support and cannot be performed on a real time basis.

Figure 4-47 gives a schematic representative of the equipment layout at each sampling station. The following instruments are operated at each sampling station:

TABLE 4-12

CURRENT APPLICABLE AMBIENT AIR QUALITY STANDARDS FOR OPERATION OF CAMDS AT TOOELE ARMY DEPOT

Pollutant	Standard
Sulfur Dioxide	0.03 ppm (80 $\mu g/m^3$) annual arithmetic mean 0.14 ppm (365 $\mu g/m^3$) (24 hr average) not to be exceeded more than once per year 0.50 ppm (1300 $\mu g/m^3$) (3 hr average) not to be exceeded more than once per year
Nitrogen Dioxide	0.05 ppm (100 $\mu g/m^3$) annual arithmetic mean
Suspended Particulates	75 $\mu g/m^3$ annual geometric mean 260 $\mu g/m^3$ (24 hr average) not to be exceeded more than once per year
Total Oxidants	0.08 ppm (160 $\mu g/m^3$) (1 hr average) not to be exceeded more than once per year
Agent HD	1 X 10^{-4} mg/m^3 (72 hr average)
Agent GB	3 X 10^{-6} mg/m^3 Maximum ground level concentration outside the physical plant
Agent VX	3 X 10^{-7} mg/m (72 hr average) (Based on allowable 24 hr exposure dosage of 5 X 10^{-3} mg min/m^3)

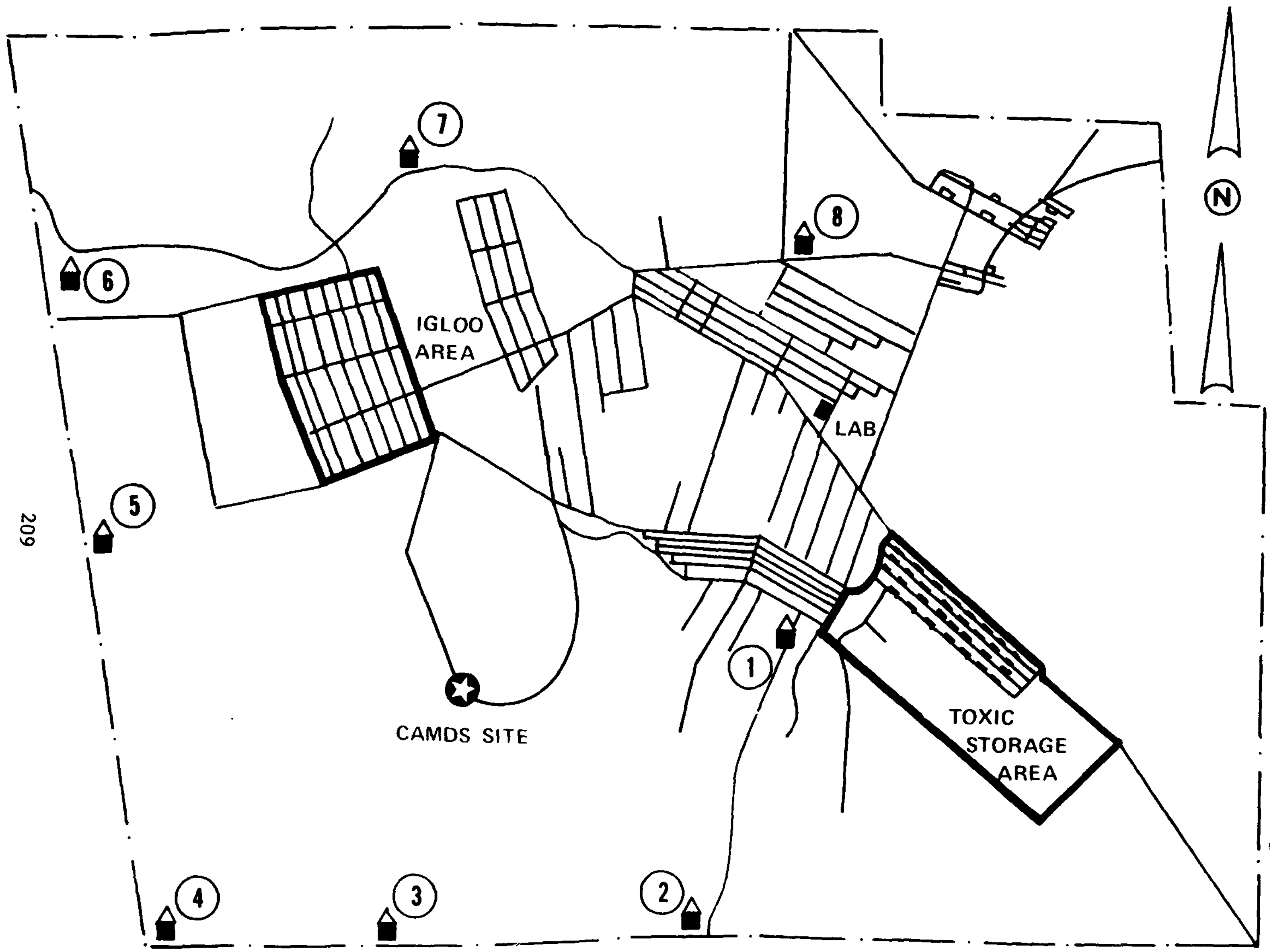


FIGURE 4-46 LOCATIONS OF PERIMETER MONITORING STATIONS

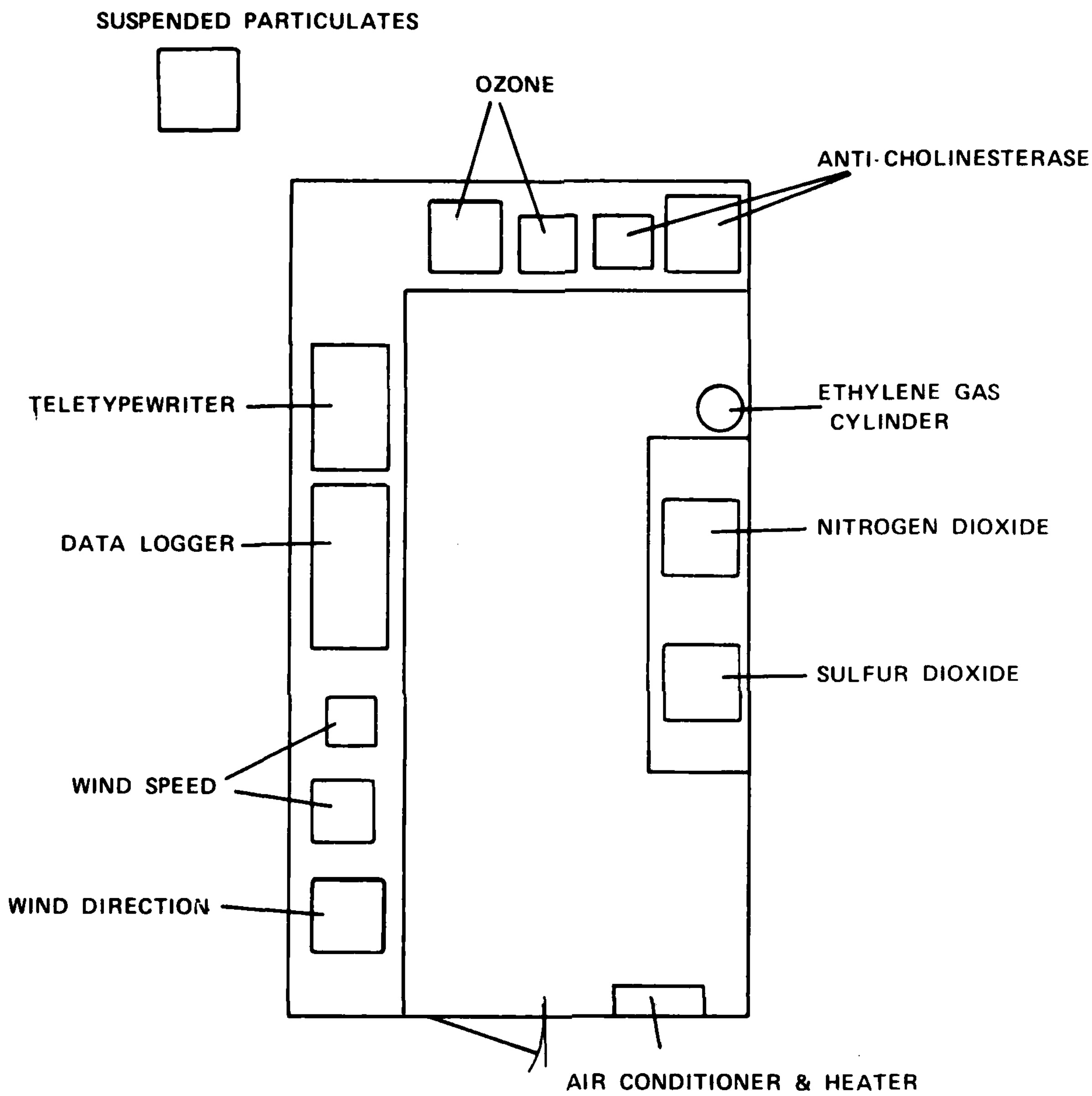


FIGURE 4-47 PERIMETER MONITORING STATION INSTRUMENT & EQUIPMENT LAYOUT

(1) MacMillan Model 1100-2 Ozone Monitor - Operates on the basis of photometric detection of chemiluminescence resulting from the flameless reaction of ethylene gas with ozone.

(2) Technicon Air Monitor II A Sulfur Dioxide Monitor - Operates on the basis of a wet chemical colorimetric reaction of sulfur dioxide with formaldehyde and p-rosaniline according to a modified West and Gaeke method.

(3) Technicon Air Monitor II A Nitrogen Dioxide Monitor - Operates on the basis of a modified Saltzman method for the wet chemical colorimetric determination of nitrogen dioxide.

(4) Climet Instruments Co. Model CI45 wind speed and wind direction monitoring system; includes Model 012-46 wind direction translator and Model 011-45 wind speed translator.

(5) Bendix Environmental Division Hi-Vol Particulate Sampler - Draws air through a pre-weighed filter pad at a high rate; the increase in the filter weight over the sampling period is calculated as suspended particulates.

(6) Bubbler Absorption System; includes a Research Appliance Corporation Model PV Sequential Sampler and a Forma Scientific, Inc. Model 2095 Constant Temperature Bath and Circulator. Air is drawn through a liquid absorbing solution at a prescribed rate for a given period of time by the sequential sampler. The absorbing solution temperature is maintained constant by the bath. The bubbler sample is subsequently analyzed in the laboratory for anti-cholinesterase activity.

(7) Monitor Labs, Inc. Model 9400 Data Logging System with a Teletype Corporation Model 33 Automatic Send-Receive Data Terminal. The data logging system conditions, averages, and prints the output signals of the five continuous, real time monitors at each station. Output will be both computer compatible punched paper tape and printed hard copy of the hourly average values of each parameter.

(8) In addition to these instruments operated at each station, other equipment to maintain the Perimeter Monitoring network include:

Monitor Labs, Inc. Model 8500 B Dynamic Calibrator. This instrument provides accurate calibration sources for sulfur dioxide, nitrogen dioxide, and ozone. Sulfur dioxide and nitrogen dioxide sources are permeation tubes. Ozone is generated by ultraviolet photolysis of oxygen in "zero air". Four calibration systems will be shifted from station to station as required.

Teletype Corporation Model 33 Automatic Send-Receive Date Terminal. To read and duplicate data logger punched paper tapes at a central office location.

c. Operation. The operating plan for the Perimeter Monitoring network formulated in conjunction with the U.S. Army Environmental Hygiene Agency includes instructions for operator training, data reduction, and instrument maintenance.

A baseline survey was conducted prior to starting demilitarization operations. The baseline survey measured average background pollution levels and seasonal trends in the pollution levels. These background pollution values can then be compared with values obtained during demilitarization operations to yield CAMDS impact, if any, upon the environment. During the baseline survey only four of the eight stations were operated.

Wind data will be analyzed in conjunction with pollution data to indicate whether pollution values are directly attributable to CAMDS operations. Wind speed and direction will also be used in determining local atmospheric mixing characteristics.

The Perimeter Monitoring Network will operate continuously after being started. The sampling stations will require daily maintenance visits to perform zero and span checks, replenish reagent supplies, return bubbler samples and particulate filters to the laboratory, and check overall instrument performance. At regular intervals each instrument will require multipoint calibrations and flow meter checks. Each instrument has specific maintenance requirements as recommended by the equipment manufacturer.

The data generated by the Perimeter Monitoring Network will be analyzed by computer to determine the relative contribution, if any, of CAMDS emissions to ambient concentrations of aerometric parameters.

Bubbler samples and particulate filters will be analyzed in the laboratory. The laboratory will also prepare all reagents required in the operation of the network.

Perimeter Monitoring Network operators must be proficient in normal operating procedures for all the network instruments, trouble shooting procedures, instrument calibration, sample identification and handling, and data handling and reduction.

d. Safety. Servicing the sampling stations does not require any special protective clothing, but caution must be used when handling the sulfur dioxide monitor reagents and waste liquids because they

contain poisonous mercury compounds. These liquids will be collected and stored at the laboratory for proper disposal. 1A cylinders of ethylene required for the oxidant instrument will be securely held in place in each sampling station.

e. References.

(1) Report by P. E. Carlson and J. A. Scuderi, Dugway Proving Ground, No. DPG-FR-C965A-I, "Meteorological Study for Tooele Army Depot", August 1974. Development and test of a mathematical model to calculate downwind concentrations of pollutants released to the atmosphere at the CAMDS site. See Incl 8. Volume II of this report, No. DPG-FR-C965A-II, contains extensive raw test data, observations and computations and was not made a part of Incl 8.

(2) Dugway Proving Ground Report No. DPG-FR-0965A, "Diffusion Climatology for Tooele Army Depot, South Area", December 1974. This report supplements the meteorological study, ref 1, by providing a climatological summary of the meteorological input parameters. The data was used to generate isopleth maps of seasonal and annual average ground-level concentrations of possible pollutants. See Inclosure 8.

(3) Letter from U.S. Army Environmental Hygiene Agency to Edgewood Arsenal, Attn: SMUEA-DM, Subject: "Air Quality Standards for the Chemical Agent/Munitions Disposal System", dated 28 Nov 72. Provides applicable ambient air quality standards for operation of the demilitarization program at the CAMDS site.

4-29 CHEMICAL LABORATORY (CML)

a. Purpose. The Chemical Laboratory provides the facility and equipment for all the analytical support required for the CAMDS site. The primary areas requiring such support are the Perimeter Monitoring Network, Detectors, Agent Destruction System, Metal Parts Furnace and Deactivation Furnace System.

b. Description. CAMDS at Tooele Army Depot uses Bldg S-541 in the South Area for its Chemical Laboratory. The existing building (formerly used as a surveillance laboratory) was modified by the addition of new toxic fume hoods, new chemical fume hoods, new work benches, laboratory work tops and sinks to handle the work load generated by the detoxification of toxic chemical agents on a large scale production basis. See floor plan in Figure 4-48.

Some of the instruments furnished in the laboratory in addition to the basic requirements include:

(1) Orion Model 701 digital pH/specific ion meter with Model 605 electrode switch and Model 751 printer. The system allows as many as six specific ion electrode determinations on a single sample without recalibration or changing the equipment arrangement. Various specific ion electrodes are available.

(2) Bausch & Lomb Spectronic 88 spectrophotometer. The spectrophotometer will measure transmittance from 325-925 mm. Flow through compartment and multiple sample compartment allow various means of sample handling. Strip chart recorder provides record of output.

(3) Hewlett-Packard Model 9810 Programmable Calculator. Performs standard mathematical and statistical functions or special programs written by the operator. Frequently used programs can be stored on magnetic cards for easy access.

(4) Technicon Auto Analyzer II systems with Research Cartridge Kit A. Allows the operator to automate colorimetric analyses. Primary use for these systems will be analysis of bubbler samples for mustard or anti-cholinesterase material. System includes automatic sampler, proportioning pump, analysis cartridge, colorimeter and recorder.

(5) Tracor Model MT220 Gas Chromatograph with 4 detectors: Electron Capture, Flame Ionization, Thermal Conductivity, and Flame Photometric. The system includes capacity for four columns, isothermal or linear temperature programming, space for four detector mounts, and on or off column sample injection. Dual channel electrometer and two dual pen recorders allow complete flexibility in operation.

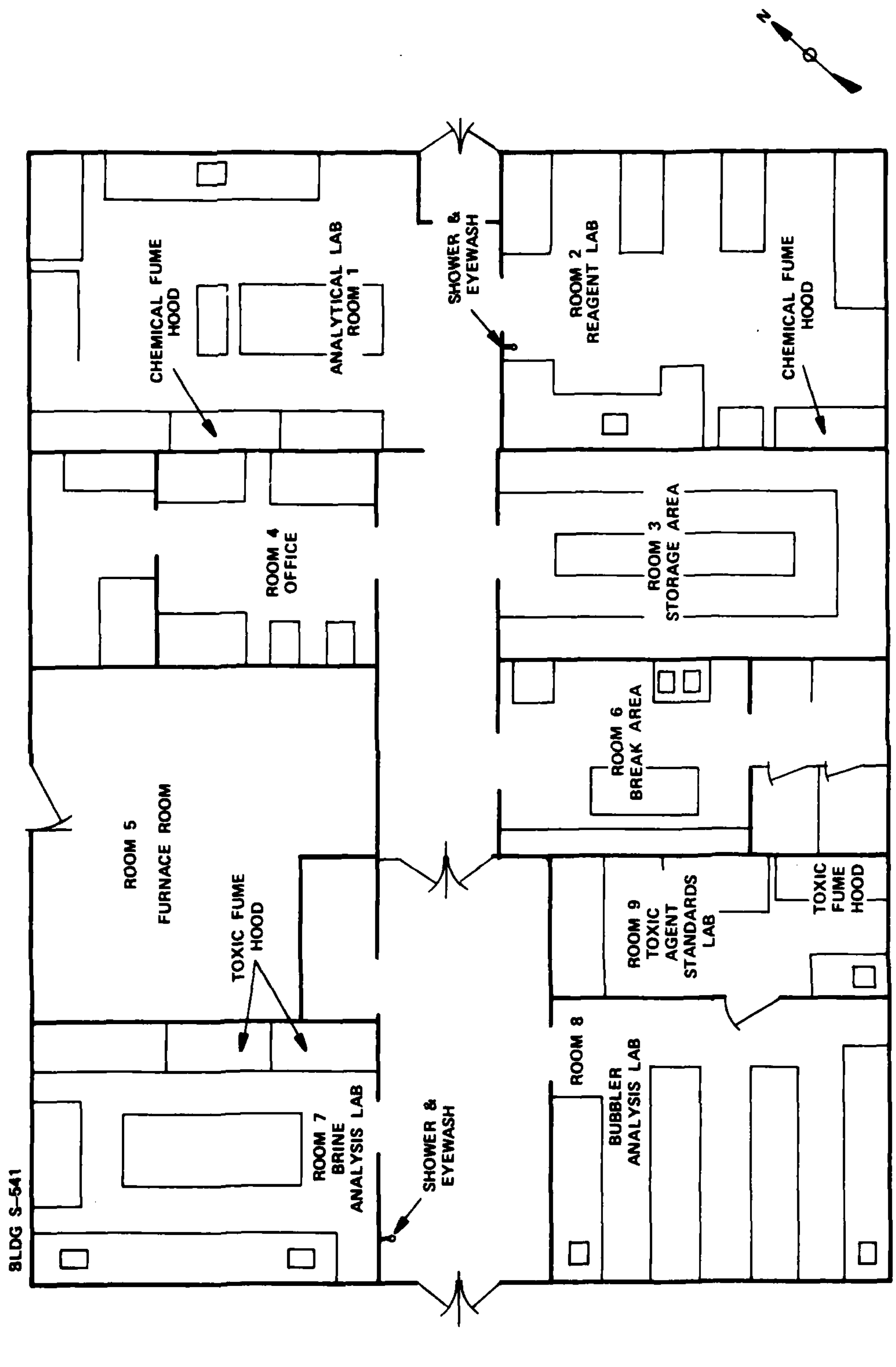


FIGURE 4-48. FLOOR PLAN OF CAMDS CHEMICAL LABORATORY

(6) Toxic fume hoods and filters. Required for work with toxic chemical agents, the hood systems (each rated at 1500 CFM) include the working hoods, an approved charcoal filter, and a blower. Up to 80% of the make-up air to each hood system can be heated for temperature control, and an auxilliary power supply is available in the event of a power failure.

c. Operation. Samples for suspended particulates and anti-cholinesterase activity collected at the Perimeter Monitoring sampling stations require analysis, and some of the ambient air quality monitors require chemical reagents. Bubblers collected for the Detectors require laboratory analysis. Brines generated in the Agent Destruction System and the furnace scrubbers must be analyzed to assure complete detoxification of the agent. Other components of the system will require analytical support in varying degrees. The Chemical Laboratory will perform routine analyses, such as pH and available chlorine, and toxic chemical analyses involving all three types of agent. The capability also exists for the laboratory to handle non-routine, complex analyses, such as elemental analyses.

The Chemical Laboratory will operate as required to support the demilitarization mission. Bubbler samples must be analyzed in a timely fashion whenever operators are working in the CAMDS area, and process samples must be analyzed to allow normal continuity of operation. Standard laboratory practice will govern most procedures regarding analysis methods, techniques, and materials. Any analyses involving toxic chemical agents will further abide by all applicable regulations and military specifications. In all cases the procedures yielding the greatest accuracy within the allowable time frame will be used.

d. Safety. The Chemical Laboratory operations will follow all applicable safety regulations in addition to standard safe laboratory procedures. Fire extinguishers, deluge showers, and eye wash fountains are provided as standard equipment. Safe handling and storage procedures will be practiced with all reagents and materials. Compressed gas cylinders will be properly secured at all times. A first aid kit, properly marked and located, will be maintained with all the necessary provisions.

Special procedures will apply to use of toxic chemical agents. All such use will be confined to an approved toxic fume hood. Operators will wear prescribed protective clothing (M9 mask, M3 hood, M2 apron, and M3 gloves). The buddy system will be used in all chemical laboratory operations involving toxic chemical agent.

SECTION 5

AGENT DETOXIFICATION/INCINERATION

5-1 PROPERTIES OF GB, VX AND MUSTARD

GB and VX are lethal nerve agents. Mustard is a blister agent used primarily for casualty effects. While the nerve agents, GB and VX, differ in molecular structure, they have the same physiological action on man in that they upset the balance between the sympathetic (adrenergic) and parasympathetic (cholinergic) nervous systems which together are the autonomic nervous system. Normally in the body there is controlled discharge within the nervous system due to destruction by cholinesterase of acetylcholine, a product of nerve cell metabolism. The nerve agents react with the cholinesterase in an irreversible reaction in tissue fluid permitting accumulation of acetylcholine and continual stimulation of the nervous system. Rapid use of so-called autonomic blocking agents which act directly on the effector nerve cell will nullify the effect of acetylcholine. No apparent chemical reaction seems to occur between these autonomic blocking agents and acetylcholine. Atropine salts are the most commonly used autonomic blocking agents. Because the major action of these chemical agents is on the parasympathetic nerve system, they are often popularly called nerve agents.

The blister agents such as mustard are used for casualty effects and affect the eyes and lungs and blister the skin. During World War I mustard was the only blister agent in major use. It was recognized by a distinctive odor and had a fairly high duration of effectiveness under normal conditions. Since then, improved mustard agents have been developed which have less odor and vary in duration of effectiveness. Most blister agents are insidious in action; there is little or no pain at the time of exposure. The development of casualties is somewhat delayed. Protection from blister agents is extremely difficult since they attack any part of the body which comes in contact with the liquid or vapor.

Properties of GB, VX and Mustard are listed in Table 5-1.

Data on GB, VX and Mustard is taken primarily from TM 3-215, Military Chemistry and Chemical Agents. This technical manual also describes the various types of mustard (H, HD, HT, etc.) and G agents (GB, GD, GA, etc.). Data on mustard in Table 5-1 is for type HD, distilled mustard. The expected chemical composition of the agents within the munitions stockpiled at Tooele Army Depot was determined by sampling a statistically significant number of each type of munition (see Inclosure 2).

TABLE 5-1 PROPERTIES OF HD, GB AND VX

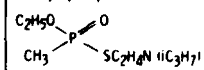
	MUSTARD (HD)	GB	VX
(1) General	HD is Mustard which has been purified by washing and vacuum distillation. HD, however, has less odor and a slightly greater blistering power (negligible in the field) and is more stable in storage than undistilled Mustard.	A colorless liquid; its vapor is also colorless.	A colorless and odorless liquid; its vapor is also colorless.
(2) Chemical Name	2, 2' - dichloro - diethyl sulfide	O - isopropyl methyl phosphonofluoridate.	O - ethyl - S - diiso propyl aminoethyl methyl phosphono - thiodate.
(3) Formula	$(ClCH_2CH_2)_2S$	$CH_3(IC_3H_7O)FPO$	
(4) Molecular Weight	159.08	140.10	267.0
(5) Vapor Density (Compared to air)	5.4	4.86	9.2
(6) Liquid Density	1.27 at 20°C	1.09 at 25°C	1.008 at 25°C
(7) Freezing Point	14°C	-56°C	-39°C
(8) Boiling Point	227.8°C	147°C	300°C
(9) Vapor Pressure	0.072mm Hg at 20°C	2.2mm Hg at 25°C	0.0007 mm Hg at 25°C
(10) Volatility	22 mg/m^3 at -18°C. (solid); 75 mg/m^3 at 0°C. (solid); 610 mg/m^3 at 20°C. (liquid); 2,857 mg/m^3 at 40°C. (liquid).	2,850 mg/m^3 at 0°C.; 16,800 mg/m^3 at 25°C.; 23,000 mg/m^3 at 30°C.	10.5 mg/m^3 at 25°C
(11) Flash Point	105°C	Non-flammable	159°C
(12) Decomposition Temperature	149° to 177°C	400 to 560°C	700 to 800°C
(13) Latent Heat of Vaporization	94 calories per gram	85 calories per gram	78 calories per gram
(14) Rate of Hydrolysis	Very slow at ordinary temperatures	Variable with pH. Very rapid in highly alkaline solutions.	Variable with pH.
(15) Odor	Similar to Garlic	Practically odorless	Odorless
(16) Median Lethal Dosage	Inhalation. 1,500 mg-min/m^3. Skin absorption (masked personnel). 10,000 mg-min/m^3.	Inhalation. 100 mg-min/m^3 for resting man; 70 mg-min/m^3 for men engaged in mild activity.	Inhalation. 20-50 mg-min/m^3
(17) Median Incapacitating Dosage	Eye injury. 200 mg-min/m^3. Skin absorption (masked personnel). 2,000 mg-min/m^3. Wet skin absorbs more mustard that dry skin. For this reason, HD exerts a casualty effect at lower concentrations in hot humid weather, since the body is then moist with perspiration. The dosage given above for skin absorption applies to temperatures of approximately 21° to 27°C., as the body would not normally be perspiring at these temperatures. Above 27°C., perspiration causes increased skin absorption. The incapacitating dosage drops rapidly as perspiration increases; at 32°C., 1,000 mg-min/m^3 could be incapacitating.	75 mg-min/m^3 for resting man. 35 mg-min/m^3 for man engaged in mild activity.	5-15 mg-min/m^3
(18) Rate of Detoxification	Very low. Even very small repeated exposures are cumulative in their effects or more than cumulative due to sensitization. This has been shown in the postwar case histories of workers in mustard-filling plants. Exposure to vapors from spilled HD causes minor symptoms such as "red eye." Repeated exposure to such vapors produced 100 percent disability by irritating the lungs and causing a chronic cough and pain in the chest.	Low detoxification rate. Essentially cumulative.	Low detoxification rate. Essentially cumulative.

TABLE 5-1 CONTINUED

	MUSTARD (HD)	GB	VX
(19) Skin and Eye Toxicity	Eyes are very susceptible to low concentrations; higher concentrations are required to produce incapacitating effects by skin absorption than by eye injury.	Eye effect. Very high toxicity; much greater through eye than through skin. Vapor causes pupil of to contract; vision difficult in dim light. Skin effect. LD_{50} 1.7 gm/man. Liquid does not injure skin but penetrates it rapidly. Immediate decontamination of the smallest drop is essential. Vapor penetrates skin also. Skin LTc_{50} of vapor is approximately 12,000 mg-min/m^3 for naked man, and 15,000 mg-min/m^3 for man in ordinary combat clothing. Median incapacitating dosage from vapor on skin is approximately 8,000 mg-min/m^3 with ordinary clothing.	Eye Effect. Very high toxicity, greater through eye than through skin. Vapors and aerosol cause pupil to contract, vision difficult in dim light. Skin Effect. LD_{50} 10 mg/man Liquid does not injure skin but penetrates it. Immediate decontamination of the smallest drop is essential. Vapors and aerosols penetrate skin also. With a 1 mph wind, Ct=3600 for clothed masked man and Ct=360 for unclothed masked man. Median incapacitating dosage on skin is [illegible] mg/man.
(20) Rate of Action	Delayed-usually 4 to 6 hours until first symptoms appear. Latent periods have been observed, however, up to 24 hours and, in rare cases, up to 12 days.	Very rapid-death usually within 15 minutes after fatal dosage absorbed	Very rapid death usually within minutes after fatal dosage absorbed.
(21) Physiological Action	Mustard acts first as a cell irritant and finally as a cell poison on all tissue surfaces contacted. The first symptoms of HD poisoning usually appear in from 4 to 6 hours; the higher the concentration, the shorter the interval time between the exposure to the agent and the first symptoms. The physiological action of HD may be classified as local and general. The local action results in conjunctivitis or inflammation of the eyes; erythema (redness of the skin) which may be followed by blistering or ulceration and inflammation of the nose, throat, trachea, bronchi, and lung tissue. Susceptibility also varies with individuals. Injuries produced by HD heal much more slowly and are more liable to infection than burns of similar intensity produced by physical means or by other chemicals. This is due to the action of HD in making the blood vessels incapable of carrying out their functions of repair, and by the fact that necrotic (dead or dying) tissue acts as a good medium for bacterial growth.	Individuals poisoned by GB display approximately the same sequence of symptoms reguardless of the route by which the poison enters the body (wether by inhalation, absorption, or ingestion). These symptoms, in normal order of appearance, are running nose; tightness of the chest, dimness of vision and pinpointing of the eye pupils; difficulty in breathing drooling and excessive sweating nausea, vomiting, cramps, and involuntary defecation and urination; twitching jerking and staggering; and headache, confusion, drowsiness, coma, and convulsion. These symptoms are followed by cessation of breathing and death. Symptoms appear much more slowly from skin dosage than from respiratory dosages. Although skin absorption great enough to cause death may occur in 1 to 2 minutes, death may be delayed for 1 to 2 hours. Respiratory lethal dosages kill in 1 to 10 minutes, and liquid in the eye kills nearly as rapidly. The number and severity of symptoms which appear are dependent on the quantity and the rate of entry of the nerve agent which is introduced into the body. (Very small skin dosages sometimes cause local sweating and tremors with little other effect).	Effects. In liquid or aerosol form VX agents affect the body in a maner similar to that of G agents. V Agents are usually disseminated as liquid droplets which produce casualties when absorbed through the skin. Since liquid G-agents evaporate quickly from the skin the dosage required to produce casualties by that route is high and the time to appearance of casualties is correspondingly short as compared with the much less volatile V agents. If evaporation is excluded the time to appearance of casualties would be roughly similar at the same dose level with both V agents and G agents. Aerosolized V agents produce [illegible] by inhalation and by absorption [illegible] agents droplets [illegible]
(22) Protection Required	Protective mask and impermeable protective clothing for vapor impermeable clothing for protection against liquid.	Protective mask and protective clothing. Ordinary clothing gives off GB for about 30 minutes after contact with vapor. This should be considered before unmasking. Immediatly remove all liquid contamination on clothing.	Field protective mask and permeable (impregnated) protective clothing protect against vapor. Impermeable clothing provides protection against liquid droplets.
(23) Decontamination	Bleach, M5 ointment, fire or DS2.	Bleach slurry, dilute alkali solution, or DS2. In confined area steam and ammonia. Hot soapy water.	For personnel decontamination, V-agents may be effectively removed from the skin by use of protective ointment or a 5 percent solution of sodium hypochlorite (household bleach in water). Prompt decontamination undertaken within 1 minute after contamination is twice as effective as it would be if delayed 5 minutes. For decontamination by means of showering, the body should be first flushed with copious quantities of cold water, then washed with plenty of soapy warm water. Surfaces and material can be effectively decontaminated with super tropical bleach, slurry, DANC solution, or DS2 solution.
(24) Duration of Effectiveness	Depends upon type of exposure (liquid, mist, vapor) and the weather. Heavily splashed liquid persists 1 to 2 days under average weather conditions, and a week or more under very cold conditions.	Evaporates at approximately the same rate as water. Depends upon type of exposure (liquid, mist, vapor and weather).	Depends upon munitions used and the weather. Heavily splashed liquid persists for long periods of time under average weather conditions.

5-2 AGENT DETOXIFICATION

a. Detoxification of GB Agent. The detoxification of GB agent has been extensively studied (see Section 5-5) and it has been determined that both neutralization and incineration processes are applicable to complete detoxification of GB. A GB neutralization process using caustic (sodium hydroxide) was in production at Rocky Mountain Arsenal between 1973 and 1977.

The complete neutralization of GB has been accomplished by reaction with either sodium hydroxide or sodium carbonate. Sodium hydroxide neutralization is the process selected for the Agent Destruction System (ADS) and a sodium carbonate decontamination process is used in the Explosive Containment Cubicle (ECC) operations since it is less reactive with aluminum components than the hydroxide.

(1) Sodium hydroxide neutralization. The rate of reaction of GB in water is base-catalyzed and is controlled both by pH and the amount of the dissolved salts. The half life for GB in water at different temperatures and pH levels was determined by Epstein (ref b and c, Section 5-5) and is presented in Table 5-2. At pH levels greater than 10, the neutralization of GB by caustic is practically instantaneous.

TABLE 5-2

HALF LIFE OF GB IN HOURS AS A FUNCTION OF PH AND TEMPERATURE

TEMPERATURE	pH				
°C	6.5	7.0	7.5	8.0	9.0
0	8300	2650	830	265	26.5
10	1870	591	187	59	6.0
20	461	146	46	15	1.5
25	237	75	24	7.5	0.8
30	125	39	12.5	4	0.4

The reaction of sodium hydroxide with GB agents is shown by the following equation:

$$CH_3-\underset{\substack{|\\ O-C_3H_7}}{\overset{\substack{O\\ \|}}{P}}-F + 2NaOH \longrightarrow NaF + H_2O + CH_3-\underset{\substack{|\\ O-C_3H_7}}{\overset{\substack{O\\ \|}}{P}}-ONa$$

In addition to the monosodium salt of isopropyl methyl phosphonic acid and sodium fluoride which is formed in the above reaction, tributylamine and tributyl quaternary ammonium salts are also found in the hydrolysis products due to the presence of tributylamine stabilizer in the GB.

A series of pilot scale neutralization studies was also conducted by Thomas (ref d, Section 5-5) to determine the time required for complete destruction of the agent and it was concluded the reaction rate was very fast and that only very low concentrations of GB remain in solution (<0.037 μg GB/ml solution) after reaction times of only five minutes. It should be noted that in the ADS, a reaction/retention time of three hours will be used to further assure complete neutralization of the GB.

(2) Sodium carbonate neutralization. Sodium carbonate also effectively neutralizes GB and is used in CAMDS decontamination operations involving aluminum components since sodium hydroxide reacts with aluminum to generate hydrogen gas. The reaction of sodium carbonate with GB is shown by the following equation:

$$CH_3-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O-C_3H_7}{|}}{P}}-F + 2Na_2CO_3 + H_2O \longrightarrow NaF + 2NaHCO_3 + CH_3-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O-C_3H_7}{|}}{P}}-ONa$$

The half life of GB in a 10% by weight Na_2CO_3 solution with seven gallons decontamination solution to one pound of GB has been measured to be on the order of 15.6 seconds.

In tests at Edgewood Arsenal in which the ratio of Na_2CO_3 solution (10% by weight) to GB was seven gallons to one pound, it was found that after one hour of contact time, the solution (measured by anticholinesterase activity) contained less than five nanogram/ml of GB. Subsequent tests run at 2 and 3 hours after contact showed no appreciable lowering of the GB concentration as measured by anticholinesterase activity. Since the activity of solutions exhibiting such behavior can not be due to GB, it is most probably due to interference from the products of the hydrolysis reaction. It is therefore certain that the actual concentration of GB remaining in the solution was much less than 5 nanograms/ml.

(3) Incineration of GB. Laboratory tests (ref e, Section 5-5) have determined that <99.99% of GB agent can be destroyed by incineration in excess air when held at 1000°C for 0.3 seconds. In addition, combining the incineration process with a gas scrubbing system can increase the efficiency of GB destruction to 99.99994%.

Pilot incineration studies at Edgewood Arsenal (ref n) demonstrated that GB can be destroyed to a degree of 99.9998%. After scrubbing of the effluent gases from the incinerator, an overall agent destruction efficiency of 99.99995% was realized.

The initial thermal decomposition of GB produces primary propylene and methylphosphono fluoridic acid by the following reaction:

$$CH_3 - \underset{OC_3H_7}{\overset{\overset{O}{\|}}{P}} - F \xrightarrow{\Delta} CH_3 - \underset{OH}{\overset{\overset{O}{\|}}{P}} - F + CH_2 = CHCH_3$$

In the presence of excess air, the thermal incineration of GB proceeds by the following reaction:

$$2CH_3 - \underset{OC_3H_7}{\overset{\overset{O}{\|}}{P}} - F + 13\ O_2 \xrightarrow{\Delta} 8CO_2 + 9H_2O + P_2O_5 + 2HF$$

In the Metal Parts Furnace (MPF) and the Deactivation Furnace System (DFS), the P_2O_5 and HF are removed by means of scrubbers and mist eliminators.

b. Detoxification of VX Agent. Extensive laboratory studies (see ref g and h, Section 5-5) have been conducted on the detoxification of VX agent. Approaches evaluated have included neutralization by both calcium hypochlorite and chlorine in an acid media and incineration at elevated temperatures.

(1) Neutralization. Laboratory investigations were performed on two chlorination procedures: calcium hypochlorite (HTH) in a basic aqueous media and chlorine gas in an aqueous acidic media. With the HTH system, a destruction efficiency of 99.995% was realized but the reaction was a very critical function of pH. With this system, the possibility of forming an intermediate compound of high toxicity exits at pH values less than 11. Destruction efficiencies of greater than 99.99999% were common in the chlorine gas system. It was found that

using three volumes of 1.25 N hydrochloric acid to dissolve one volume of VX produced optimum results. Experimentally, it was found that a molar ratio of 3:1 chlorine to VX was required for complete reaction.

Pilot scale experiments were performed on three chlorine gas systems. Such studies demonstrated that destruction efficiencies of 99.99999% could be visualized using the 3:1 volume ratio system (hydrochloric acid to VX). Two major reaction products were observed: Diisopropyltaurine hydrochloride and O-ethyl methanephosphonic acid. The decon solutions showed no cholinergic signs in toxicity screening tests. See Table 5-3.

Although the level of detoxification of VX using 15% calcium hypochlorite with a molar ratio of 11:1 hypochlorite to agent was 99.995%, only half of the theoretical amount of sulfur was isolated as calcium sulfate. This implies that at least a portion of the remaining sulfur is in the form of hydrogen sulfide. From the variety of reaction products observed in the decon solution, it would be difficult to fully characterize the reaction. From the experimental data, it appears that attack is not only occurring at the phosphorus atom but at the sulfur and nitrogen atoms of VX. This system was eliminated from further study and was not included in pilot scale studies since the acid chlorinolysis system offered more effective detoxification.

The acid chlorinolysis system (chlorination in an aqueous acidic media) provided the best overall VX destruction system. Several laboratory tests were performed in order to optimize the relative volume of hydrochloric acid (12 normal) to VX. Volume ratios of 50:1, 25:1, 6.7:1, 3:1, 2:1, and 1:1 hydrochloric acid to VX were tried on a batch laboratory scale. The 50:1 through 3:1 volume ratio systems provided a VX destruction efficiency of greater than 99.999% by gas chromatographic analysis. The 2:1 and 1:1 volume ratio systems were considerably less efficient with a VX destruction efficiency in the range of 98.79 to 99.994%. The LD_{50} of the decon solutions ranged from 2100 mg^3/kg to 680 mg^3/kg. Enzymatic analysis of the 3:1 volume ratio system decon solution after 19 days shows a final VX concentration of 148 μg/l (initial VX concentration was 2.5×10^8 μg/l) or a destruction level of 99.99994%.

Further laboratory scale experiments were conducted using the 3:1 volume ratio system to ascertain if the final VX concentration changed as a function of time in the decon solution. In this study, a more sophisticated analytical procedure was used for the analysis which involved preparative layer chromatography followed by selective enzymatic analysis of the VX region. Within the experimentally derived accuracy limits of the analysis the final VX concentration did not significantly change during a 7-day period after the end of the reaction. The average VX concentration was 3 ± 2 micrograms/liter (initial VX concentration = 2.5×10^8 μg/l) or a destruction efficiency of greater than 99.99999%.

TABLE 5-3

CHANGE IN VX CONCENTRATION AS A FUNCTION OF TIME

SAMPLE NO.	SAMPLING TIME INTERVAL	VX CONCENTRATION (MICROGRAM/LITER) INITIAL	FINAL	AVERAGE	PERCENT DECONTAMINATION
1	Peak Reaction		4		
2	Temperature	2.5×10^8	6	4 ± 1	99.99999%
3			2		
4			<1		
5	One Hour	2.5×10^8	1	4 ± 4	99.99999%
6			9		
7			11		
8	One Day	2.5×10^8	<1	5 ± 4	99.99999%
9			2		
10			2		
11	Two Days	2.5×10^8	<1	2 ± 1	99.999999%
12			2		
13			3		
14	Five Days	2.5×10^8	2	2 ± 1	99.999999%
15			1		
16			2		
17	Seven Days	2.5×10^8	3	2 ± 1	99.999999%
18			2		

(2) Incineration. Laboratory studies have indicated that VX can be destroyed to a minimum extent of 99.995% by incineration in excess air when held at 1000-1100°C for 0.25 seconds. The chemicals produced in this thermal detoxification are NO_x, P_2O_5, SO_2, CO_2, and H_2O. These products can be removed by the use of scrubbers and mist eliminators.

The studies were carried out in a 1 inch diameter Hastelloy B tube heated by a 1 foot long tubular, electric furnace. The inlet of the tube was fitted with a propane fuel burner, agent evaporator and combustion air inlets. This arrangement allowed the VX to be vaporized by a hot air stream and to be carried into the propane burner zone.

Effluent gases from the incinerator passed through a condenser, four liquid filled traps and a dry-ice trap. The high efficiency of this assembly in the collection of undetoxified VX was experimentally verified. The degree of detoxification of VX was determined by measuring the anticholinesterase activity of the condenser and trap solutions. All measured activity was considered to have come from intact VX and the final calculation of percent destruction was made on this basis.

The detoxification experiments were divided into two distinct phases. A high temperature series of runs utilized both the propane burner (direct fired) and the electric furnace (indirect fired) as heat sources. Incinerator conditions ranged from 1000-1100°C with a retention time of 0.25 seconds. The second phase directly introduced VX into the propane flame. Conditions ranged from 700-800°F with a retention time of 0.20 seconds.

A total of 376.2 gm of VX was incinerated in fifteen high temperature runs. A total of 19,567 μg of VX was indicated by anticholinesterase activity measurements. From these figures, a percent destruction 99.995% was calculated. Since 85% of the total amount of anticholinesterase activity came from one run, this percentage is conservative. If the data from the run is considered atypical and eliminated from the totals, the average percent destruction for the remaining 14 runs would be 99.9991%.

A total of 178.4 gm of VX was incinerated in six low temperature direct fired runs. The VX feed rate was comparable to that of the high temperature runs. A total of 47,892 μg of VX was indicated by anticholinesterase activity. The percent destruction based on these totals is 99.97%. (In scale-up to industrial equipment the degree of VX detoxification should be higher due to improved mixing conditions.)

In conjunction with incinerator tests, a separate laboratory investigation was conducted on the joint absorption of SO_2 and NO_x. While the removal of SO_2 and P_2O_5 is within the current state-of-the-art, details of the absorption of NO_x in the presence of SO_2 have not been reported in the literature. In the scrubbing experiments, NO_x was removed

from an air stream containing .01 mole fraction SO_2. In several experiments, a packed bed absorber containing a moderate height of packing (3 feet) successfully removed more than 95% of the nitric oxide from the air stream.

Pilot incineration studies at Edgewood Arsenal (ref n) demonstrated that VX could be destroyed to a degree greater than 99.9999%. After scrubbing the effluent gases from the incinerator, an overall agent destruction efficiency greater than 99.99999% was realized.

c. Detoxification of Mustard Agent. The detoxification of mustard has been extensively studied (ref j, Section 5-5) at Edgewood Arsenal and it has been determined that a mustard destruction efficiency of better than 99.9994% can be assured. The incineration reaction of mustard with the oxygen in air is as follows:

$$(ClC_2H_4)_2S + 6.5\ O_2 \xrightarrow{\Delta} 4CO_2 + SO_2 + 2HCl + 3H_2O$$

Prior to the Edgewood Arsenal investigations, field experiments by the British on burning mixtures of mustard and gasoline in a preheated, modified smoke generator produced a yellow flame and smoke, but mustard was not detected 30 and 100 yards downwind with the then available detector systems. In 1945, 47 tons of mustard were burned in open trays (British Zone in Germany) on a ton-per-day basis. Voluminous black smoke was observed, although mustard was not detected at either 100 meters or 6 kilometers downwind. Subjectively, no downwind casualties were reported due to the burning operation.

AiResearch, a division of Garrett Corp., studied the fundamentals of the thermal decomposition of mustard vapor when mixed with air. These studies, over a temperature range of 250° to 400°C, were conducted in reactor tube assemblies that allowed variation in total residence time, and in packed (catalytic versus uncatalytic packing) versus unpacked tubes. At a residence time of 0.4 seconds in an unpacked tube maintained at approximately 400°C, 98.8% of the mustard was decomposed. In a tube packed with 1% platinum on a 35/65 mesh aluminum oxide support, mustard vapor was "completely" mineralized at 275°C. Based on data obtained on unpacked reactors, over the experimental range of 250° to 400°C, the slope of the Arrhenius plot of the thermal oxidation gave rate-constants (K) of $1.78 \times 10^9\ e\ (-25{,}070/RT)\ sec^{-1}$. When extrapolated to 468°C and 482°C, incineration efficiencies of 99.9% and 99.99% were predicted for a residence time of 0.1 seconds.

In the continental United States, mustard contained in 3407 ton containers had been incinerated and the effluent gases effectively scrubbed at Rocky Mountain Arsenal during the period of July 1971 to June 1974. Burning of mustard was highly effective based on stack monitoring data.

Reports are available on related work carried out as early as 1918. These reports were concerned with problems that might be associated with the flashing of mustard in artillery shells and represented experiments on the heating of mustard from 100° to 1000°C. The results of these investigations led to further experiments to show that tail-gases from mustard manufacturing processes could be destroyed (burned) in a coal-fired furnace. The data suffered only because of a lack of sophistication in analytical methodology (including specificity, accuracy, and completeness of information) and in validity of conclusions.

The original Edgewood Arsenal study included a simulation, at laboratory level, of mustard incineration at a temperature akin to that of a fuel-fired furnace (such as the hydrazine furnace at RMA). A temperature isotherm of 800°C was found acceptable. The primary information obtained was the nature of the mineralized product, the possible presence and identification of organosulfur or organochlorine residues from combustion, and the quantity of distilled mustard that might still remain intact in effluent from the furnace. Additional experimental requirements were added to supply data for both incinerator designs. Included in this data were: scrubber studies, i.e., nature of scrubber, pH versus gaseous incinerator effluents, pH versus odor of scrubber residues; efficiency of laboratory incineration, including residual intact mustard; the adaptation or development of analytical methods; and suggested simulants that might be substituted for mustard during the initial incinerator check-out period.

On the basis of the Edgewood Arsenal laboratory investigations made on two all-glass incinerators operating at 800°C, it was found that a mustard destruction efficiency of better than 99.9994% can be assured. The value cited for efficiency is limited only by the capability of the analytical instrumentation.

5-3 AGENT NEUTRALIZATION USING THE CAMDS AGENT DESTRUCTION SYSTEM (ADS)

a. GB Neutralization. The CAMDS GB detoxification process is modeled after existing facilities now in operation at Rocky Mountain Arsenal (RMA) with certain equipment configuration modifications. In the ADS design, the sodium hydroxide (NaOH) and GB are blended in the reactor rather than in a mixing tee as done at RMA. These modifications eliminate foaming and line plugging problems and improve process operations in general. Also, these changes permit the same vessels to be used for processing detoxified VX (acid brine).

In the sodium hydroxide neutralization process used to detoxify GB in the ADS, the caustic reacts chemically with the GB to form sodium isopropyl methylphosphonate, sodium fluoride and water as per the following equation:

$$CH_3 - \underset{OC_3H_7}{\overset{\overset{\displaystyle O}{\|}}{P}} - F + 2NaOH \longrightarrow CH_3 - \underset{OC_3H_7}{\overset{\overset{\displaystyle O}{\|}}{P}} - ONa + NaF + H_2O$$

Refer to Section 4-16 for details on the ADS equipment.

In the ADS process, a small heel of NaOH is first added to the reaction vessel. Following this, NaOH and GB are gravity fed simultaneously into the reactor until the batch tanks have been emptied. The reaction is exothermic, necessitating quick removal of the heat of reaction (30 kilocarlories per gram mole of GB). The heat of reaction is removed by circulating the agent/caustic solution through a recirculation cooler and back to the reaction vessel. The overhead condenser serves to reflux any vapors that form during the reaction. Should the reaction temperature become excessively high (over 190°F), the GB flow is automatically reduced or terminated thus quenching the reaction. At least five percent excess NaOH is added to assure complete GB detoxification. The reaction will require about three hours time before complete GB detoxification is achieved.

b. VX Neutralization. VX agent is neutralized in the Agent Destruction System (ADS). The VX detoxification process consists of two steps. The first step is an acid chlorinolysis reaction; and the second step is caustic neutralization of the acid solution formed in the first step. In order to conserve acid, the process is designed to recycle the acid formed during the reaction of the VX with chlorine in subsequent reaction batches. A complete series of runs consists of an initial, fresh acid run followed by six recycle runs. In the initial run, fresh 1.5 N

hydrochloric acid (HCl) is fed to the batch tank. In all succeeding runs, a portion of the acid solution from the previous run is recycled to the batch tank and diluted in water (two parts water to one part acid solution, by volume) in the reactor.

(1) **Acid Chlorinolysis.** In the acid chlorinolysis step of the VX detoxification process, the chlorine reacts chemically with the VX acid solution to form O-ethylmethyl phosphonic acid, di-isopropyltaurine, and HCl, as per the following equation:

$$CH_3-\underset{OC_2H_5}{\overset{O}{\overset{\|}{P}}}-S-C_2H_4N(iC_3H_7)_2 + 3Cl_2 + 4\ H_2O \longrightarrow$$

$$CH_3-\underset{OC_2H_5}{\overset{O}{\overset{\|}{P}}}-OH + HO_3SC_2H_4N(iC_3H_7)_2 + 6HCl$$

To initiate process operations, the HCl is gravity fed to the reactor. Then the VX is added by gravity feed to the HCl in the reactor to solubilize the VX before the chlorine is added. To start the reaction, chlorine is slowly fed from the batch tank to the reactor. The reaction is exothermic (60 kilocalories per gram mole of CL) and the reaction temperature will peak out at approximately 220°F. The VX agent contains a stabilizer which must be kept in solution during the course of the reaction to insure complete detoxification. To accomplish this, it is necessary to add external heat from the jacket heating system for a thirty minute period after the reaction temperature has peaked.

The HCl:VX ratio as determined empirically for the reaction is about 3 to 1 by volume. The chlorine:VX stoichiometric molar ratio is also 3 to 1. Based on pilot development runs, approximately 30 percent excess chlorine must be added to insure complete detoxification of the VX solution.

Acid and water vapors distilled off during the course of the reaction are refluxed in the overhead condenser. Unreacted chlorine will pass through the overhead condenser and will be chemically converted to sodium hypochlorite and sodium chloride in the process vent scrubber system.

The reactor jacket cooling system is used primarily to remove the heat of reaction during chlorination of the VX. Should reaction temperatures become excessively high (over 240°F), the chlorine flow will be reduced or terminated automatically thus quenching the reaction. It is

also used to remove the heat of solution caused by dissolving the VX in the HCl. Approximately three hours of reaction time is required to assure that all VX has been completely detoxified.

(2) Caustic Neutralization. The acid solution from the acid chlorinolysis step must be neutralized with caustic to make a brine that can be handled by the ADS drying equipment. This necessitates adding 50 percent caustic (NaOH) to raise the pH to 9-11 and convert the acid reaction products to salt.

The reaction of caustic with the acid decon solution produces the sodium salt of O-ethylmethyl phosphonic acid di-isopropyltaurine, and sodium chloride as end products. Neutralization of the VX acid solution, which is the second step of the overall VX detoxification process, proceeds in much the same manner using a GB detox reaction system as the straight GB neutralization.

To start the process, a reactor system is selected and the caustic batch tank charged with sufficient caustic to insure complete neutralization of the VX decon solution. In most cases, ten percent excess caustic will be added to insure that the resultant brine solution attains a pH in the range of 9-11. After the caustic has been added, the VX acid decon solution is slowly fed into the GB reactor from a VX detox reactor. The reaction between the caustic and acid solution is somewhat exothermic and the solution temperature will rise to approximately 175°F. The heat of reaction will be removed by circulating the resultant brine solution through the recirculation coolers.

The reaction products resulting from caustic neutralization are principally sodium organic salts and sodium chloride. Some of the salts precipitate during the course of the reaction forming a brine slurry. When neutralization operations are completed, this brine slurry is transferred to the brine holding tanks in the bulk reduction section.

5-4 AGENT INCINERATION USING THE CAMDS METAL PARTS FURNACE (MPF)

The incineration of agent using the MPF involves both (a) the volatilization of the agent from the munition in a volatilization chamber, and subsequent incineration of the vapor in the primary and auxiliary fume burners, and (b) the incineration in the burnout chamber of any residual agent remaining in the munition after volatilization. The auxiliary fume burner is also utilized to incinerate any residual agent not completely decomposed in the PFB or burnout chamber.

The MPF is a zoned, roller hearth furnace containing a punching chamber equipped for bulk container twin punch operation; a volatilization chamber designed for operation over a 500-1000°F range; a burnout chamber designed for operation at 1000-1100°F; a primary fume burner and auxiliary fume burner designed for operation at 1600°F; and a gas quench tower and scrubber system to remove particulates and SO_2 effluvia. A complete description of the MPF facility is presented in Section 4-11.

a. Operation of Volatilization and Burnout Chambers. The method of operation of the MPF is dependent on the munition to be incinerated. The following describes the operation for ton containers, projectiles and drained munitions/bulk containers with respect to the volatilization chamber and burnout chamber. Operating temperature of the fume burners is 1600°F regardless of the munition being processed.

(1) Mustard ton containers. The volatilization chamber is equipped with two sets of controlled air/fuel ratio burners, one consisting of conventional over and under-firing burners for control of chamber wall temperature during heat-up and a second set located opposite the centerline of ton containers for impingement heating during both the heat-up and controlled vaporization periods. At the start of the heating period the chamber wall temperature is maintained at about 900°F by a differential head controller (DHC). Midway through the heat-up period the DHC drops the wall temperature to 600°F and maintains this temperature until the heat-up is completed (1 hour). A temperature rise of about 100°F in the product stream from the primary fume burner (PFB) indicates that mustard vaporization has commenced.

Tests at Rocky Mountain Arsenal (ref k, Section 5-5) on full ton containers disclosed that the temperature of the flue gases leaving the PFB gave a more rapid and sensitive response to changes in mustard volatilization rate than furnace wall temperature or even direct measurement of ton containers wall temperature. Accordingly, the combustion air input to the PFB is controlled as required to maintain the operating temperature at the desired rate of mustard volatilization.

The fuel input to the volatilization chamber is controlled to maintain a constant temperature of 1600°F in the PFB when the PFB is supplied with its rated combustion air. As the residual mustard agent in the ton container decreases, the temperature in the volatilization chamber increases to maintain the desired volatilization rate. The volatilization chamber temperature reaches its upper limit of 900°F but the mustard volatilization rate starts to decrease as the residual mustard is consumed. At this point, the combustion air to the PFB starts decreasing to maintain 1600°F in the PFB. When the PFB combustion air reaches its minimum, volatilization is completed so an interlock will be made, and the ton container is moved to the burnout chamber.

The time-temperature profile for the total heating process is shown schematically on Figure 5-1.

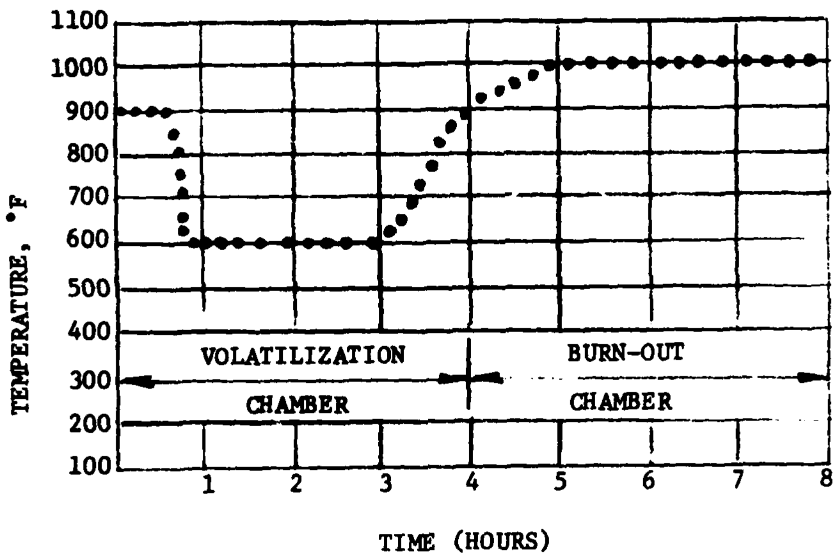


FIGURE 5-1 TIME-TEMPERATURE CHART, TON CONTAINERS

The burnout chamber is controlled to maintain the metal parts at a minimum temperature of 1000°F. The load temperature will reach the set point very rapidly because of the small temperature rise needed (100°F).

(2) Mustard projectiles. Theoretical heat transfer calculations show that a volatilization chamber temperature of 1000°F will be required to heat the filled projectile to the volatilization temperature in a 15 minute heat-up period.

As in the case of the filled ton containers, a controller decreases the volatilization chamber wall temperature to about 700°F just before the end of the heating period. Because of the limited time available for temperature changes, use of a large amount of excess dilution steam will be required.

When a 100°F increase in PFB flue temperature indicates that volatilization has begun, the fuel input to the burners of the volatilization chamber will be controlled to maintain a constant flue temperature of 1600°F in the PFB when it is supplied with its rated combustion air. The remaining part of the cycle is identical to the filled mustard ton container. The volatilization chamber continues to rise in temperature as mustard is consumed. At this point, the combustion air to the PFB starts decreasing to maintain the 1600°F temperature.

The time-temperature profile for the total heating process for filled projectiles is shown schematically in Figure 5-2.

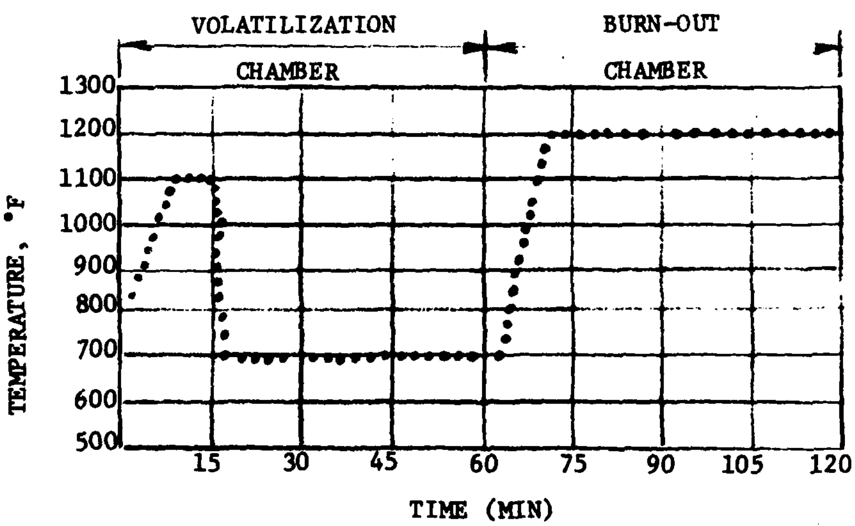


FIGURE 5-2 TIME-TEMPERATURE CHART, PROJECTILES

If mustard is completely evaporated in the volatilization chamber, the burnout chamber wall temperature will be maintained at 1200°F to heat the projectiles from 700°F to 1000°F in the allowed 66 minute cycle period. If residual mustard remains in the projectiles, it will be consumed in the burnout chamber. This chamber is controlled at 1000°F since the quantity of residual agent is small enough that controlled volatilization will not be necessary.

(3) Drained munitions and bulk containers. The only cases to be considered for this type operation are drained munitions and containers having less than 5 percent GB and VX. All mustard agent munitions and containers are processed in the filled state.

Although the thermal requirements of drained loads are such that complete detoxification can be achieved in 2 hours or less, the thermal operations described herein is based on design cycle times of 4 hours for the bulk containers and 66 minutes for the 155mm projectile.

The RMA tests (ref k, Section 5-5) indicate that ton containers with up to 15 percent of the filled charge weight of agent do not reach a steady state volatilization condition but evaporate the agent as a short duration pulse. Accordingly, the PFB flue temperature control mode is not effective for drained munitions and containers and the preferred control variable is the temperature of volatilization chamber wall. Therefore, the volatilization chamber wall temperature is maintained at a constant 900°F for drained projectile loads and at a constant 600°F for the drained container loads. Volatilization of GB and VX must be completed in volatilization chamber to insure that incineration takes place in both the primary and auxiliary fume burners.

The flue products from the burnout chamber are vented directly to the auxiliary fume burner. As in the case of filled containers, the burnout chamber will be maintained at a temperature of 1000-1100°F.

b. Fume Burners. Flue gases from both the punching chamber and the volatilization chamber flow to a primary fume burner (PFB). Flue gases from the PFB and the burnout chamber are ducted to an auxiliary fume burner (AFB) for final afterburning at a nominal temperature of 1600°F. Minimum residence time in each fume burner is 0.5 seconds giving a residence time for the bulk of the mustard fumes of 1.0 seconds. The minimum total residence time for the VX and GB fumes will be 2.6 seconds at 1600°F.

5-5 REFERENCES

a. "Military Chemistry and Chemical Agents" TM3-215; Department of the Army and Air Force; December 1963. Manual provided most of the data on GB and Mustard Agent. Data on VX in the manual was incomplete since VX was classified at the time the manual was published.

b. "Studies on Hydrolysis of GB", Joseph Epstein and Virginia Bauer; Medical Division Report No. 147; Edgewood Arsenal; June 1948. Study investigated the effect of natural waters on the hydrolysis of GB agent. Specific on pH effects were evaluated.

c. "Properties of GB in Water"; Joseph Epstein, Journal American Water Works Associations; Vol 66, No. 1; Jan 1974. Study of hydrolysis of GB agent as a function of pH and temperature.

d. "Pilot Scale GB Neutralization Studies", George W. Thomas; Edgewood Arsenal; Dec 1972. Pilot studies of the neutralization of GB agent using various concentrations of sodium hydroxide. Effect of concentration and feed rates considered. Both batch and continuous neutralization operations were evaluated. See Incl 10.

e. "Incineration of GB and Containment of Gaseous Products" D. Pugh, J. Baker, T. Gervasoni, and H. Hildebrandt; Edgewood Arsenal Technical Report 4463; October 1970. Investigation verified that GB can be totally detoxified by incineration and that the gaseous products for the incineration can be contained within the limits imposed by air pollution standards. See Incl 7.

f. "Process Design of the ADS for CAMDS", Engineering Report No. 1, Contract DAAA15-74-C-0063, Stearns-Roger Incorporated, Denver, Colorado, July 1974. This report describes the process design of the ADS. As such it represents the culmination of major efforts in many development areas including laboratory and pilot plant testing, evaluation of process data, establishment of design criteria and equipment sizing calculations.

g. "GB/VX Chemical Neutralization Process Studies, Final Evaluation Report, Piloting Test Program", November 1974; Stearns-Roger Inc. under contract DAAA15-74-C-0063. Report summarizes and evaluates all process data and design information acquired from various pilot plant test programs. The acid chlorinolysis process was found to be a viable means of detoxifying VX. See Incl 10.

h. "Heat of Reaction of VX with Alkaline Bleach Solutions", Joseph Epstein, DF to Chief, Demil/Disposal Office; Edgewood Arsenal, May 1975. Use of alkaline bleach solutions for decontamination of VX. Data supplied on heat and velocity of the reaction as well as the chemistry pertinent to safety requirements on the use of bleach solutions in selected situations. See Incl 10.

i. "Laboratory and Pilot Scale Studies on the Chemical Destruction of Agent VX", Jack Benson, MTD, Edgewood Arsenal, Dec 1972. Study to determine the feasibility of using chemical means to destroy VX on a large scale. Two chlorination procedures were used. Calcium hypochlorite (HTH) in a basic media and chlorine gas in an acid media. Both laboratory and pilot scale experiments were conducted. See Incl 10.

j. "Laboratory Studies in the Incineration of Mustard", Samuel Sass and Paul Davis; Edgewood Arsenal, Technical Report EATR 4516; Edgewood Arsenal; May 1971. Study developed data on the destruction of mustard by incineration of 800°C in the presence of burning hydrocarbon fuel and determined the extent of total mineralization of organic material. See Incl 7.

k. CAMDS Test Summary, "Pilot Test Results (Heavy HD Ton Containers)", S. Lawhorne, 1 May 74. Ton containers with up to 1800 pounds of mustard can be detoxified at a controlled rate.

l. CAMDS Test Summary, "Pilot Test Results (Projectiles)"; S. Lawhorne, 4 April 74. The results of incineration tests on projectiles filled with mustard under different specified conditions.

m. CAMDS Test Summary, "Statistically Significant Sampling Program"; S. Lawhorne, 26 Jun 74. This sampling program characterized the agent in the stockpiled munitions at Tooele Army Depot. See Incl 2.

n. "Pilot Scale Incineration of GB and VX and the Containment of Gaseous Products", Dennis J. Wynne, Edgewood Arsenal, Dec 1972. Study provided pilot plant data verifying the feasibility of thermal destruction of GB and VX.

o. "Incineration of VX and Containment of Gaseous Products", H. F. Hildebrandt, T. R. Gervasoni, J. A. Baker, March 1972. These lab experiments demonstrated that VX can be destroyed to a minimum extent of 99.995% by incineration in excess air, in a tubular furnace, when held at 1000-1100°C for 0.25 seconds; or 99.97% at 700-800°C for 0.20 seconds.

SECTION 6

PRODUCT DISPOSAL

6-1 PROCESS DESCRIPTION

a. Salt Solutions. Salt solutions from the Deactivation Furnace System (DFS) scrubber, the Agent Destruction System (ADS), and the Metal Parts Furnace (MPF) scrubber are sent to brine hold tanks near their respective sources until they are ready to be dried. These brine solutions will be certified agent-free by measuring pH and excess caustic. The solutions from the DFS and the MPF brine hold tanks are piped to separate hold tanks in the non-toxic area of the ADS. (See flow sheet in Figure 4-34.) The solutions are then dried on two twin drum dryers also located in the non-toxic area of the ADS. Each dryer has a nominal capaci ty of 5 gallons per minute of feed solution and requires about 2,500 pounds per hour of 125 psig saturated steam from the CAMDS facility boilers. The drum temperature during drying is approximately 350°F. The approximate composition of the salts is shown in Table 6-1. The twin drum dryers in the ADS are equipped with a "bag house" particulate collection system. The "doctor" blades on each dryer, used to scrape the salts off the drums are air swept to carry any particulates generated directly to the bag house particulate collection system. This system minimizes the release of particulates to the ADS effluent stack.

Spent decon solutions from the Bulk Item Facility (BIF), the Explosive Treatment System (ETS), Projectile Disassembly Facility (PDF), and from other sources such as sumps, are piped to a waste neutralization tank in the toxic area of the ADS. The spent decon is held in this tank for caustic adjustment and, after it is certified agent-free by measuring pH and caustic content, it is pumped to a brine holding tank to await drying. It is then dried on the twin drum dryers in the ADS. All process aqueous wastes and washdown solutions will be dried on the ADS dryers.

After the salts are discharged from the dryers, they may be either conveyed directly to fiber storage drums or to a solids compactor, as deemed appropriate. In the compactor, the bulk density of the salt is increased from about 25 pounds to approximately 50 pounds per cubic foot.

After compacting, the salts are conveyed to a feed hopper. The salts are then fed into 55 gallon fiber drums using a vibratory feeder. Each drum body is fiberboard wrapped with integral polyethylene liner between wrappings. Drum lids have neoprene rubber gaskets to insure that the drums are air tight. The drums are filled on a volume basis by using a sensor to determine when the salts reach a predetermined height in the drum.

TABLE 6-1

APPROXIMATE COMPOSITION OF CAMDS SALTS

	Percent
Deactivation Furnace System	
GB Disposal	
Na_2CO_3	27
Na NO_2	30
NaF	4
Na_2SO_4	10
Na_2PO_4	16
Na Cl	1
Moisture	12
Metal Parts Furnace	
Mustard Disposal	
Na_2CO_3	25
Na Cl	29
Na_2SO_4	32
Na OH	trace
Moisture	14
Agent Destruction System	
VX Disposal	
Sodium O-Ethyl Methyl Phosphonate	18
Sodium Salt of Diisopropyl Taurene	30
Na Cl	45
Na OH	2
Moisture	5
GB Disposal	
Sodium O-Isopropyl Methyl Phosphonate	68
NaF	18
Na OH	1
Moisture	13

After the drums are filled, they are placed on pallets (four per pallet) and trucked to the salt storage site. Salts will be stored in metal sheds in a restricted portion of the South Area. Additional details on the handling and processing of the salt solutions are presented in Section 4-16, Agent Destruction.

The salts that will be generated from the overall CAMDS program are as follows:

GB Salts	1,580,000 lbs.
VX Salts	240,000 lbs.
Mustard Salts	217,000 lbs.

A DOT toxicity screening test was performed on GB, VX and mustard salts of the type that would be generated from the CAMDS operation. All three salts were classified less than class B poison.

b. Inert Parts - Deactivation Furnace Processing. After passing through the DFS, the residual material falls onto an alloy steel mesh belt conveyor which is located in a pit below the furnace level. This conveyor is, for all practical purposes, a hot belt furnace and is housed in an insulated, electrically heated enclosure designed to provide sufficient holding time at a temperature to insure detoxification of agent. The parts then pass through a trickle valve onto a conveyor with flights which lifts the decontaminated debris to an elevation such that the material can be discharged into a truck for transport to a holding area to await disposal. The scrap conveyor is TV monitored and is equipped with motion switches and alarm circuits to provide indication of jamming. Also, the conveyor is equipped with a reverse jogging push-button to aid operators in clearing jammed material. Fiberglass and scrap from rocket demilitarization will be disposed of in a suitable landfill.

c. Metal Parts - Metal Parts Furnace Processing. After the bulk item, projectile, and miscellaneous parts scrap are suitably cooled in the MPF air cooling chambers, the scrap is handled as follows:

(1) Scrap from bulk item processing is conveyed on trays using the discharge car to shuttle the trays to an off-loading roller conveyor located in the receiving and unloading area. Transfer of the bulk items from trays to a truck is accomplished by manual manipulation of a rail crane and hoist. The hoist is suitably equipped with an electromagnet designed to adapt to the various bulk items.

(2) Scrap projectiles are lifted from the trays and placed in trucks using a rail crane. The rail crane electrical hoist has remote controls for manual operation of the equipment.

(3) Scrap parts in containerized trays are off-loaded by dumping the trays using the rail crane and hoist directly into a scrap truck.

The metal parts are transported by truck to a holding area to await disposal. Sections 4-10 and 4-11 provide additional information on the processing of metal parts through the DFS and the MPF.

6-2 DRUMMED SALTS

The palletized drums of salt are stored in a suitable building at the Tooele Army Depot South Area. There are primary medium bituminous roads in good condition that run from the CAMDS site to the storage building or to the general area of the storage building. In the latter case, dirt roads extend from the primary roads to the storage building.

The salts generated from this demilitarization program have been shown, through studies conducted by the Office of the DA Project Manager for Chemical Demilitarization and Installation Restoration, to be void of commercial value. Therefore, the ultimate method of disposal may be in a scientific landfill, operated by a private concern, which has the capability to control the leachate from the landfill. The salts from the CAMDS operation will be held in storage at Tooele Army Depot until a specific disposal site is selected or until an alternate procedure for final disposal is developed.

6-3 METAL PARTS

The metal parts from the Metal Parts Furnace (MPF) and the Deactivation Furnace System (DFS) are stored on open ammunition storage pads at the Tooele Army Depot South Area. The pads are approximately 100 feet X 200 feet. The primary roads to the area of the pads are of medium bituminous construction and in good condition. However, the secondary roads from primary roads to the pads are dirt. Drummed fiberous scrap from the DFS will be stored in a suitable building within the Tooele Army Depot South Area pending selection of a suitable landfill for burial or selection of an alternate disposal procedure.

6-4 CERTIFICATION

a. Certification of Salts. The salts from the CAMDS dryers will be sampled periodically to determine composition before being released for final disposition. The salts will be certified prior to being released for final disposition.

b. Certification of Metal Parts and Scrap. A certificate of destruction and a certificate of decontamination is prepared for each load of metal parts and scrap from the Deactivation Furnace System (DFS) and the Metal Parts Furnace (MPF). The metal parts will ultimately be transferred to the Property Disposal Office, Tooele Army Depot, for disposal.

SECTION 7

HAZARD AND SAFETY ANALYSES

7-1 PURPOSE

The purpose of Failure Modes and Effects Analysis (FMEA) is to identify potential hazards and failure modes that could conceivably result in an impact on the environment and/or compromise the health and safety of personnel and the civilian population.

7-2 ANALYSES

FMEA is an inductive analysis that systematically evaluates all contributing component failure modes and identifies the resulting effect to the system. For purposes of establishing criticality indexes, failure rates are qualitatively identified at four levels: level 1, negative failure probability, level 2, low failure probability; level 3, 50 percent failure probability; level 4, high failure probability. Hazard levels are defined in relative terms at four levels: category I, negligible; category II, marginal; category III, critical; category IV, catastrophic.

The criticality index is an orderly indication of the relative criticality of an identified failure resulting from the combination of the severity level and the assigned frequency of failure level. The criticality number is computed for each critical failure mode and is basically the probability of a given mode producing a stated critical event. Criticality index is highest when both the severity level and the assigned frequency are highest. A low criticality index number indicates identification of a relatively less important failure mode.

Failure Modes and Effects Analysis charts and logic diagrams illustrate inductive analyses that consistently evaluate all contributory component failure modes and identify the resulting effect to the system.

7-3 CONCLUSION

No single point failure that could be classified as a category IV (catastrophic) situation was found to exist in any CAMDS building block based on an FMEA conducted by TRW and contained in Inclosure 3. The designs, configurations, processes, and procedures (many of which have been validated via tests) were found to incorporate deterrent features to the extent that two or more failures must occur prior to developing catastrophic conditions.

Deleterious effects to the environment as a result of demilitarization operations are not probable. Based on the TRW failure analysis, no single point failure will result in emissions that will exceed the approved DHEW standards.

System safety engineering, in compliance with the intent and purpose of MIL-STD-882, has been demonstrated throughout the design phase of the CAMDS. Conduct of the Safety Analysis and Hazard Evaluation has resulted in recognition of safety provisions for all identified hazardous conditions. No single point failures were found to exist which could result in any catastrophic hazardous conditions.

Reference.

TRW Report No. 95436-002, by TRW Environmental Services, "Safety Analyses and Hazard Evaluation Report, Failure Modes and Effects Analysis for CAMDS", 2 October 1975. Contains FMEA charts, Logic Diagrams and Analysis for the CAMDS. This report is contained in Inclosure 3.

SECTION 8

SAFETY, SECURITY, MEDICAL AND MANAGEMENT CONTROLS

8-1 SAFETY

a. Basic Guidelines and Concepts. Safety has been of paramount importance during the development of the CAMDS. Safety considerations during system development included designing of equipment and facilities to ensure maximum agent surety, complete agent and explosive containment and remote or automated munition demilitarization to remove personnel from potentially hazardous areas. Agent detection methods and personnel protective devices and measures have been selected to provide maximum operational safety. CAMDS facilities are in compliance with the current air quality standards.

A representative of the Depot Safety Division is assigned to the CAMDS operation to continuously evaluate the safety of equipment, procedures and operations.

The CAMDS training program will assure that all personnel are given thorough training prior to start-up. The program allows for complete training of all operation and maintenance personnel, including training with simulant/non-explosive then simulant/explosive prior to start-up of toxic/explosive demil operations. Supervisors will be responsible for follow-up training. Updating standing operating procedures and supplementing them as necessary with detailed programs of instruction or on the job training is included in the program. Methods of selection, training, and follow-up medical surveillance of personnel handling hazardous materials will reflect current, accepted practices in other toxic demil operations such as those at Rocky Mountain Arsenal.

Safety is emphasized as a line responsibility. Personnel safety performance will be included in performance appraisal procedures.

b. Safety Engineering. Safety engineers representing the DA Project Manager for Chemical Demilitarization and Installation Restoration, Chemical Systems Laboratory and Tooele Army Depot, are continually reviewing design concepts to determine hazards inherent in any proposed operation. Every effort is exercised to eliminate personnel hazard points and provide redundance in safety features. This includes working with operating organizations to identify hazards and developing methods of eliminating or reducing them to an acceptable level. Safety engineers also analyze each operation with respect to hazards and develop personnel protective equipment requirements adequate for complete safety.

Safety standards for working with agents and explosives are updated to reflect the latest information from higher headquarters and

to ensure compliance with current safety regulations and directives. These serve as the basis for developing operating procedures. Each SOP is reviewed to assure that it contains sufficient detailed working directions, follows methods conducive to maximum safety, gives clear direction as to requirements for protective clothing and safety equipment and established explosive and personnel limits.

Plans and designs are continually reviewed to assure that they are in consonance with current safety regulations of all command levels. This includes assuring that necessary submissions are made and approvals obtained.

c. Safety Criteria. Atmospheric discharge during operations must not exceed the levels contained in Section 4-27. Any release of agent as a result of an accident must be contained within the operating housing and must not expose personnel to hazardous concentrations. The Explosive Containment Cubicle (ECC) must be capable of containing the detonation of a burstered munition and control the agent released from such an event to a level which can be safely removed by the air filtration system of the ECC housing.

Personnel contact with agent-filled munitions and explosive components during operations is avoided whenever possible. Operations which involve agent are conducted in areas having adequate ventilation.

When performing maintenance, appropriate protective clothing will be worn. Emergency (standby) power will be provided to all subsystems requiring such power for safety or operational requirements.

d. Detection Systems. Detectors within the CAMDS site and an air monitoring system with eight stations around the perimeter of the South Area continuously collect and analyze air samples. Detectors monitor all process areas to assure personnel safety and also monitor plant effluent to preclude undesirable emissions. Data from the Perimeter Monitoring System is compared to baseline data to determine emission levels from the CAMDS site. A detailed description of the Detection System is contained in Section 4-27. The Perimeter Monitoring System is described in Section 4-28.

e. Site Plan Approval. Safety approval of the site plan for the Pilot Transportable Facility (now designated as Chemical Agent Munitions Disposal System) was granted by Headquarters, AMC (first indorsement), on 19 October 1970. The Armed Services Explosive Safety Board (ASESB) approved the site plan (second indorsement) on 21 October 1970. An updated site plan for CAMDS has been submitted by Tooele Army Depot.

f. CAMDS Safety Submission. The ASESB approval of the site plan was contingent upon a detailed safety plan submission for the CAMDS

operation. The state of development of the system since that time, and the multitude of changes that occurred during the interim period, prohibited an early submission of the overall safety plan. This demilitarization plan was prepared to satisfy the safety submission requirements of DOD 5154.45 and AMCR 385-100.

g. Standing Operating Procedures. In accordance with AMCR 385-100 and AMCR 750-14, all operations within the CAMDS will be conducted in strict accordance with applicable standing operating procedures (SOPs). Although the format for the procedures may be modified due to the complexity of the operation, all procedures will be reviewed by the appropriate organizational elements and approved by the Commanding Officer or his designated representative.

The CAMDS SOPs will include as a minimum such items as safety requirements, personnel protective clothing and equipment, personnel and explosives or materials limits, equipment designation, and location and sequence of operations. SOPs for CAMDS will bear the signatures required by AMCR 750-14 and will also include the signature of the TEAD CAMDS Director, Surety Officer and Medical Officer. Contractor furnished procedures will be adapted to the approved format.

h. Personnel Protective Clothing. The level of protection required for each operation or situation will be determined based on the potential hazard. Level A protection will be required in the Explosive Containment Cubicle (ECC), the ECC housing, the toxic cubicle of the Agent Destruction System (ADS), the charge car area of the Metal Parts Furnace (MPF), the Bulk Item Facility (BIF), and the Projectile Disassembly Facility (PDF). The standard M3 protective suit will be used for surveillance operations and to respond to emergency situations where speed and mobility are overriding considerations. The new Demilitarization Protective Ensemble (DPE), which is an air supplied suit, will be used for all other operations, unless a specific exception is requested and granted. A surveillance program will be used to periodically destructively test a representative sample of rubber suits, gloves and boots after they have been in service for a prescribed number of hours. This test will consist of an agent penetration test to determine if the protective equipment is still suitable for use.

The disposable protective ensemble consists of a reusable air-supplied respirator and a ventilated, disposable outergarment. The respirator utilizes a pressure demand regulator and incorporates a full face piece and a 10-minute self-contained air supply for emergency use. The respirator system provides for automatic switchover to the emergency air supply

when the main air supply pressure drops to a prescribed level. A warning device in the mask face piece informs the worker that he is utilizing his emergency air supply. The outergarment is a heat-sealed, one piece garment fabricated from a material that is resistant to agent penetration and any deleterious effects of operational fluids, such as hydraulic fluids, cutting oils and decontamination solutions. Air from the main air base will be distributed to the outergarment extremities to provide cooling for the wearer. The worker will wear a pair of M2A1 butyl rubber boots and a pair of M4 butyl rubber gloves as part of the ensemble. A surveillance program, similar to the one described for the M3 suit, will be conducted for the rubber boots and gloves used with the protective ensemble.

During use in a toxic environment, breathable air will be supplied via a high pressure umbilical connected to the air supply outlet. The making and breaking of air supply connections within the toxic area will be minimized as much as practicable, however, an in-line filter is incorporated into the respirator design to protect against agent incursion during hook-up. Specialized hose handling equipment will be available to assist the worker in movement into, within, and out of the toxic environment.

(1) The different levels of clothing for GB and VX protection are as follows:

(a) Level A. Level A clothing will be worn in proximity to spilled agents, in areas of high atmospheric contamination, during decontaminating operations, when handling items which are known to be contaminated or leakage is suspected and when drawing liquid samples from bulk containers or agent-filled munitions.

(b) Level B. Level B clothing will be worn when performing operations where contact with suspect items is required, but there is no visible or detectable agent present. This level of clothing may also be worn when accomplishing monitoring inspections of outside storage areas and by trained emergency personnel responding to an accident or incident.

(c) Level C (GB only). Level C will be worn by personnel who must be in the immediate operating area where suspect items or equipment are present, but whose duties do not require them to be in contact with the item.

(d) Level D (VX only). Level D will be worn by personnel who must be in the immediate area of outside operations, where suspect items or equipment are present but whose duties do not require them to be in contact with items.

(e) Level E (GB & VX). Level E clothing will be worn by personnel who must observe or supervise the operation, and who would not likely contact an item or would only be exposed to agent in the event of an accident. The area will be free of atmospheric contamination. This level may be used by personnel working with clean items or materials, by laboratory personnel, and by depot personnel working around clean items.

(f) Level F. Level F clothing will be worn by visitors or casual personnel who may be observing operations or items in an area where hazardous materials are stored, or in clean operating areas (uncontaminated igloo, laboratory, test area, depot storage and operating plants).

(2) The different levels of clothing for mustard protection are as follows:

(a) Level A. Level A clothing will be worn in proximity to spilled agents, in areas of high atmospheric contamination, during decontaminating operations, when handling items which are known to be contaminated or leakage is suspected and when drawing liquid samples from bulk containers or agent-filled munitions.

(b) Level B. Level B clothing will be worn when performing operations where contact with suspect items is required, but there is no visible or detectable agent present. This level of clothing may also be worn when accomplishing monitoring inspections of outside storage areas and by trained emergency personnel responding to an accident or incident.

(c) Level C. Level C clothing will be worn by personnel performing operations in clean areas where handling or contact with clean agent-filled items are involved.

(d) Level D. Level D will be worn by personnel who may be required to work in clean areas where mustard items are stored or where mustard operations are conducted and contact with items is not involved.

(e) Level E. Level E will be worn by personnel performing duties in laboratory or similar-type operations.

(f) Level F. Level F will be limited to casual or transient personnel who may be required to visit clean storage or operating areas.

(3) Clothing requirements for the different levels are:

(a) Level A (GB & VX)

Suit—coveralls, toxicological agent protective (M3) or supplied air impermeable protective ensemble
Hood—toxicological agent protective (M3)
Butyl boots—safety toe, toxicological agent protective (M2A1)
Butyl gloves—(M3 for M3 suit or M4 for M5 suit)
Cooling suit (when required)
Undershirt—unimpregnated
Drawers—unimpregnated
Socks—unimpregnated
Mask—worn; M9 series, or self-contained breathing apparatus (with a face piece compatible with the M3 Hood), i.e., M15 breathing apparatus

(b) Level B (GB & VX)

Coveralls—explosives handlers, unimpregnated
Hood—toxicological agent protective M3 for M9 mask or M6A2 for M17 mask
Butyl apron—extending below top of boots (M2)
Butyl boots—safety toe, toxicological agent protective (M2A1)
Butyl gloves—unimpregnated (M3)
Undershirt—unimpregnated
Drawers—unimpregnated
Socks—unimpregnated
Mask—worn; M9 or M17 series

(c) Level C (for GB only)

Coveralls—explosive handlers, unimpregnated
Butyl boots—safety toe, toxicological agent protective (M2A1)
Butyl gloves—M3
Undershirt—unimpregnated
Drawers—unimpregnated
Socks—unimpregnated
Mask—worn; M9 or M17 series

(d) Level D (for VX only)

Coveralls—explosives handlers, unimpregnated
Butyl boots—safety toe, toxicological agent protective (M2A1)
Butyl gloves—M3
Undershirt—unimpregnated
Drawers—unimpregnated
Socks—unimpregnated
Mask—slung position; M9 or M17 series

(e) Level E (GB & VX)

Coveralls—explosives handlers, unimpregnated
Safety shoes
Undershirt—unimpregnated
Drawers—unimpregnated
Socks—unimpregnated
Mask—slung position; M9 or M17 series

(f) Level F (GB & VX)

Street attire
Mask—slung position; M9 or M17 series

(g) Level A (H/HD/HT)

Suit—coveralls, toxicological agent protective (M3) or supplied air impermeable protective ensemble
Hood—toxicological agent protective (M3)
Butyl boots—safety toe, toxicological agent protective (M2A1)
Butyl gloves—M3
Cooling suit (when required)
Undershirt—impregnated
Drawers—impregnated
Socks—impregnated
Mask—worn; M9A1, or self-contained breathing apparatus
An M5 supplied air impermeable protective outfit may be worn in lieu of the self-contained breathing apparatus and other clothing in oxygen deficient areas of high agent concentration.

(h) Level B (H/HD/HT)

Coveralls—explosives handlers, impregnated
Hood—toxicological agent protective M3 or M6
Butyl apron—toxicological agent protective (M2)
Butyl boots—safety toe, toxicological agent protective (M2A1)
Butyl gloves—M3 or M6
Undershirt—impregnated
Drawers—impregnated
Socks—impregnated
Mask—M9 series worn

(i) Level C (H/HD/HT)

Coveralls—explosives handlers, unimpregnated
Butyl apron—toxicological agent protective M2
Butyl boots—safety toe, toxicological agent protective (M2A1)
Butyl gloves—M3 or M6

Undershirt—unimpregnated
Drawers—unimpregnated
Socks—unimpregnated
Mask—M9 or M17 series in slung position

(j) Level D (H/HD/HT)

Coveralls—explosive handlers, unimpregnated
Safety shoes
Undershirt—unimpregnated
Drawers—unimpregnated
Socks—unimpregnated
Mask—M9 or M17 series in slung position

(k) Level E (H/HD/HT)

Street clothing with laboratory coat
Mask—M9 or M17 series readily available at work station

(l) Level F (H/HD/HT)

Street clothing
Mask—M9 or M17 series in slung position

i. Safety Responsibilities of the CAMDS Directorate (CD). Since the operation of the CAMDS will be a depot operation, it is subject to depot safety regulations. DR 385-2, Safety Program, prescribes the Tooele Army Depot (TEAD) Safety Program and will serve as the basic document for establishing and implementing the TEAD Safety Program within the CD. This document is the basis from which an organized effort of accident prevention involving personnel, equipment, or property under the jurisdiction of the Commanding Officer is implemented.

j. TEAD Safety Division Support for the CAMDS Operation. The Safety Division will provide continuous on site support during system operation.

k. CAMDS Training Requirements.

(1) All CD personnel directly involved in the "demil" operation will be thoroughly trained in the general operation and in the particular procedures and hazards of their work.

(2) All CD personnel will be required to participate in a continuous program of operational safety, and first aid/self-aid indoctrination. The program will include:

First aid, self-aid (Location and application)
Artificial respiration
Recognition of signs and symptoms of nerve-agent poisoning
Care and proficient use of protective equipment
Operational and general safety requirements
Emergency and evacuation procedures

The Chemical Surety Basic Course presently taught by the Chemical Surety Officer and his staff will provide the majority of the above requirements.

(3) TEAD Safety Division will participate in developing and presenting a more comprehensive training program for those CD and depot support personnel who will be required to perform specific functions, such as working in level A clothing for the purpose of decontamination, performing maintenance or handling of leakers, etc.

(4) All personnel working in CAMDS operations will be required to familiarize themselves with applicable portions of SOPs before starting to work.

l. Chemical Surety Program. All CD personnel, as well as other personnel involved in the actual operation of the CAMDS facility, will be required to comply with the provisions of TEAD Supplement 1 to AR 11-17 "Chemical Surety Program", as well as with pertinent and/or applicable references as identified in the current AMC Chemical Surety Bulletin. Personnel Suitability and Reliability as defined by AR 50-6 will be handled on an individual basis.

m. References.

(1) DOD 5154.4, The Department of Defense Explosives Safety Board.

(2) DOD 5154.45, DOD Ammunition and Explosives Safety Standards.

(3) AR 11-17, TEAD Supplement 1, Chemical Surety Program.

(4) AR 50-6, Chemical Surety Program.

(5) AR 385-10, Army Safety Program.

(6) AR 385-61, Safety Program for Chemical Agents and Associated Weapons Systems.

(7) AR 385-64, Ammunition and Explosives Safety Standards.

(8) DARCOMR 11-37, Chemical Surety and Operational Readiness.

(9) AMCR 385-31, Safety Regulations for Chemical Agents, H, HD, and HT.

(10) AMCR 385-100, AMC Safety Manual.

(11) DARCOMR 385-102, Safety Regulations for Chemical Agents GB and VX.

(12) AMCR 750-14, Preparation of Standing Operating Procedures (SOPs) for Ammunition Operations.

(13) TEAD DR 385-2, Safety Program.

(14) TEAD Chemical Accident Incident Control Plan.

8-2 PHYSICAL SECURITY

a. Responsibility. The security officer (Chief, Security Division) is responsible for the overall physical security program for the CAMDS. The physical security program for CAMDS will comply with the TEAD security plan and depot regulatory criteria which it implements. The physical security plan, dated 10 November 1972 (currently amended through 29 April 1977), will be revised to include CAMDS peculiar physical security requirements.

b. Physical Security Plan for Chemical Areas. The basic policies governing the physical security of chemical agents and munitions in storage and operating areas are contained in AR 50-6, Chemical Surety Program. Those policies and additional guidance contained in DARCOMR 190-3, Preservation of Order Activities, were used by the Security Officer in the development of the Physical Security Plan.

c. Minimum Physical Security Standards for Chemical Exclusion Areas. All depot level directives, plans, procedures, etc., involved will be revised to reflect the addition of the CAMDS site as a "Chemical Exclusion Area" in the same manner as Toxic Storage Areas 2 and 10 are presently indentified. Further, the laboratory (Building 541) will be identified as a Chemical Exclusion Area. Figure 8-1 depicts the areas as they will exist in the South Area after CAMDS is in operation.

(1) Access. Access to the CAMDS site will be controlled by security personnel. Personnel entry to the CAMDS site will be through a guarded badge exchange area. Access List/Entry Control Rosters will be prepared in accordance with AR 50-6. These rosters will contain the names of individuals authorized entry on a continuous basis. Positive identification will be required in conjunction with Access Lists/Entry Control Rosters and the number of personnel authorized access will be kept to a minimum. Personnel not listed on the roster may be admitted to the area when a representative of the CAMDS Directorate verifies the individuals need for access and appropriate identification has been issued. Continuous escort will be provided.

(2) Protective barriers. The entire perimeter of the CAMDS site is enclosed by a type FE-6 fence having 7'0" high chain-link fabric with an angular barbed-wire top guard extending an additional foot. Gates will be controlled at all times and locked during non-operational hours.

TOOELE ARMY DEPOT - SOUTH AREA

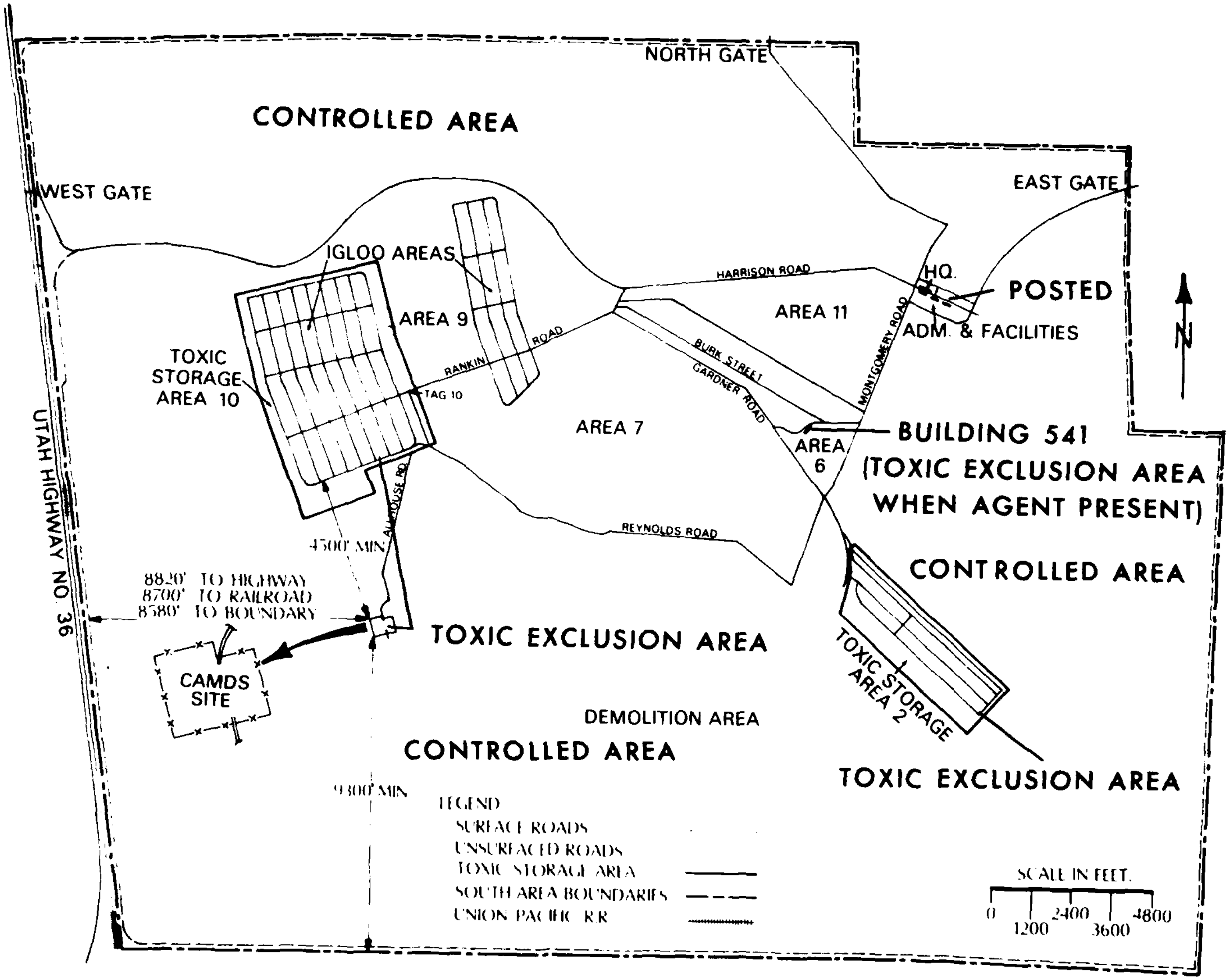


FIGURE 8-1 SOUTH AREA MAP SHOWING CONTROLLED AREAS

(3) Posting of signs. Signs will be posted in accordance with AR 380-20.

(4) Security patrol requirements. Patrols will be accomplished as required by AR 50-6.

d. References.

(1) TEAD Physical Security Plan.

(2) AR 50-6, Chemical Surety Program.

(3) AR 380-20, Security, Restricted Areas.

(4) DARCOMR 190-3, Preservation of Order Activities.

8-3 MEDICAL PLAN

a. General. Tooele Army Depot has prepared a Depot Medical Plan which will include CAMDS operations. The plan was established in accordance with applicable regulations and includes personnel fitness determination, anticholinesterase program, and establishes procedures to follow in emergency situations.

b. Personnel Fitness and Training. All personnel involved in the operation of CAMDS will be given pre-assignment medical examinations to determine that they are suitable to work in areas involving toxic operations. This examination includes personnel fitness to wear respirators/ protective masks and toxic munitions protective clothing.

Prior to start of operations in the CAMDS, the physicians at Tooele Army Depot will have received the required training at the Chemical Systems Laboratory in the treatment of personnel exposed to chemical agents. The other medical support personnel will have onsite training consistent with their patient treatment responsibilities.

All personnel directly involved in CAMDS operations will be trained to recognize the symptoms of agent exposure, to understand the short and long term significance of agent exposure, and to render emergency treatment. The training will be repeated at 6-month intervals.

c. Medical Program. All personnel directly involved in CAMDS operations will be given a medical examination prior to their employment at the CAMDS site, annually, on termination of employment, and any other occasion deemed necessary by a physician. The medical program is discussed in Inclosure 19.

d. Emergencies. A medical emergency plan has been established to handle chemical agent casualties at the South Area.

An emergency aid station will be located at the CAMDS site and manned with two specially trained medical technicians 24 hours a day. The station will provide all necessary emergency medical support for CAMDS casualties. Two evacuation ambulances are available at the TEAD South Area administration building (S-10). Physicians and backup technicians and vehicle response from the TEAD North Area to the South Area is 25 to 40 minutes depending on weather.

Staffing levels in support of a chemical accident/incident at TEAD include three physicians, nine health technicians, two nurses and seven support personnel. Six ambulances will be available for use in emergency situations.

The ambulances are satisfactory for over the highway evacuation. Medical support agreements have been made with Hill Air Force Base, University of Utah Medical Center, Veterans Administration Hospital, LDS Hospital and Tooele Valley Hospital. Copies of these agreements are contained in Inclosure 19.

8-4 MANAGEMENT CONTROLS

a. Organization. The CAMDS Directorate organization is depicted in Figure 8-2. The Director will be responsible for managing the overall system including scheduling, reporting, funding, supply, and inventory control. Operations Division will operate and maintain the CAMDS. Engineering Division will provide engineers and technical support of CAMDS, maintain drawings and manuals and supervise modifications. Laboratory Support Division will provide support for CAMDS including perimeter monitoring, detectors, alarms, analysis of salts, etc.

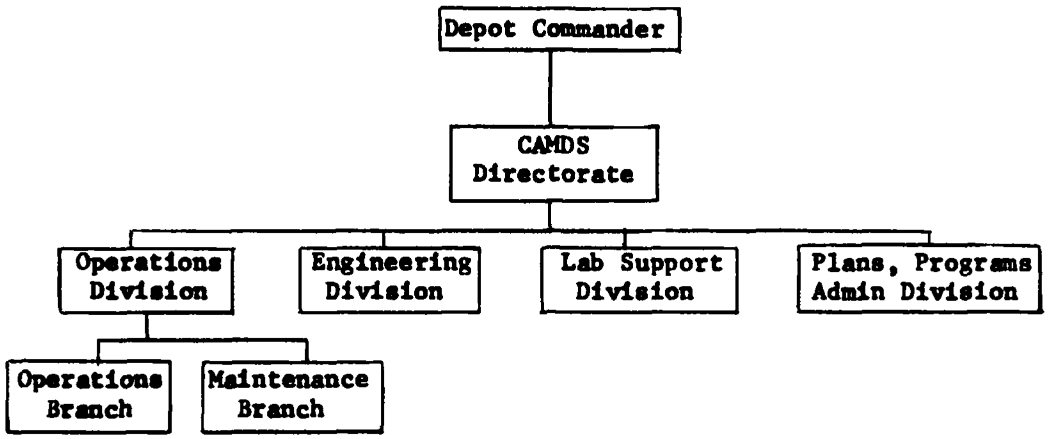


FIGURE 8-2 CD ORGANIZATION

b. Scheduling and Reporting. Scheduling and reporting will be accomplished in a manner similar to the procedures presently used for guided missile, special weapons, and conventional ammunition reporting. AMC Form 1397R, Ammunition Demilitarization Authorization and Program Status Report, will be used by the Armaments Command to authorize demilitarization. The same form will be used to schedule the workload and report progress on a monthly basis. The CAMDS Directorate will implement an internal production reporting system essential for effective management of the program.

c. Training. A training plan for CAMDS is presently being formulated. This plan recognizes the need for a formal program of instruction directed toward the needs of three levels of involvement, i.e., management, maintenance and operation. Comprehensive training will be conducted for all personnel prior to start-up of the operation. The program will stress the requirement for absolute safety and decisive immediate action in the event of an emergency.

The training program will consist of classroom instruction on the munitions and agents, process and equipment, procedures, and safety and toxic agent first aid, and will also include application of classroom instruction in practical exercises to be considered using system hardware, mock-ups and other training aids.

The requirement for training on contractor furnished equipment and systems has been included in the contractual documents. This training will cover the operation and maintenance of all equipment to be furnished on contract.

d. Accountability Procedures. Stringent accountability procedures and documentation will be maintained for all materiel processed through the CAMDS. The accountability procedures will be consistent with applicable regulations and will be implemented within TEAD by a depot regulation.

The documentation process described in Table 8-1 provides a detailed record of authorization for demilitarization, transfer of ammunition from one account to another, physical movement of stocks from storage to the CAMDS site, demilitarization accomplishment and pickup/disposal of residue material. The depot regulation covering the process will detail the preparation, distribution, processing and retention of all documentation involved in the CAMDS operation. This procedure will provide a definitive record of all demilitarization activities for reference and audit purposes.

e. References.

(1) AMCR 740-18, Production Planning and Control of Supply Operations.

(2) AMCR 740-21, Ammunition Receiving.

(3) AMCR 740-25, Ammunition Stock Location System.

(4) AMCR 750-14, Standing Operating Procedures.

(5) AMCR 755-3, Mechanized Accounting Procedures for Property Disposal Activities.

(6) AMCR 755-8, Authorizing and Reporting of Demilitarization of Class V Materials.

TABLE 8-1
ACCOUNTABILITY DOCUMENTATION

DOCUMENT	PURPOSE
DD 1348-1 DOD Single Line Item Release/ Receipt Document	Assets transferred from the ARMCOM B14 account to the Special Holding Account.
SPEEDEX LAC4F Ammunition Lot File (AMCR 740-21)	Assets recorded in Demil Account (11P).
AMC 1397R Ammunition Demilitarization Authorization and Program Status Report (AMCR 755-8)	ARMCOM authorizes demil of assets.
AMXTE Form 1983 Ammunition Operations Planning and Accomplishment Report	CAMDS Directorate directs and schedules demil of assets.
AMC Form 1493 Ammunition Transfer Record (AMCR 740-25)	Directorate of Supply (Munitions Division) prepares transfer record to show movement of stocks from storage to the CAMDS site.
AMC Form 1493 Ammunition Transfer Record (AMCR 740-25)	CAMDS Directorate personnel certify demil of assets (verified by Ammunition Surveillance Division)
DD Form 1348-1 DOD Single Line Item Release/Receipt Document	Metal parts generated by the CAMDS are shipped to the Director of Property Disposal Office (D/PDO). Material generated during the operation, i.e., fuzes, propellant, salts, etc., are either shipped to the main depot for demil or picked up in the 11D account (Consolidation Property). When scrap is shipped to the D/PDO, a certification is made that the material is decontaminated (verified by Ammunition Surveillance Division).

GLOSSARY

ABBREVIATIONS

CD	CAMDS Directorate
CFM	Cubic feet per minute
Code H	Unserviceable
Decon	Decontamination
Demil	Demilitarization
DF	Disposition Form
GPM, gpm	Gallons per minute
HE	High Explosive
hp	Horsepower
LD	Lethal dose to 50 percent of the experimental population
l	Liter
mg	Milligram
N	Normal
N/A	Not Available
nm	nanometer
NSN	National Stock Number
pH	Log of the reciprocal of the hydrogen ion concentration
ppm	Parts per million
psi	Pounds per square inch
QD/SCG	Quantity distance/storage compatibility group
rpm	Revolutions per minute
SPORT	Single Pallet Only Rocket Transporter
ug	Microgram
$>$	Greater than
$<$	Less than

GLOSSARY (CONT)

BUILDING BLOCK NOMENCLATURE

01-UPA	Unpack Area
02-ECC	Explosive Containment Cubicle
03/04-DFS	Deactivation Furnace System
05-MPF	Metal Parts Furnace
06-RDM	Rocket Demil Machine
07-DUN	Dunnage Incinerator
08-UTL	Utilities
09-EHM	ECC Hydraulic Module
10-CON	Control Module
12-PSC	Personnel Support Complex
13-ADS	Agent Destruction System
14-ETS	Explosive Treatment System
15-PDM	Projectile Demil Machine
17-TAW	Thaw System (Not being used)
18-PPD	Projectile Pull & Drain Machine
19-CDS	Central Decon System
20-PDF	Projectile Disassembly Facility
21-BIF	Bulk Item Facility
22-MHE	Material Handling Equipment
23-FIL	Filter System
24-MOR	Mortar Demil Machine
25-MIN	Mine Demil Machine
26-PIP	Piping
27-ELE	Electrical
28-MOD	Scale Model (Not being used)
29-PER	Perimeter Monitoring
30-CTV	Closed Circuit Television
31-COM	Communications
32-CML	Chemical Laboratory
33-DET	Detectors
34-TDP	Technical Data Package
35-SCS	Site Control System
36-TNG	Training
37-RAM	Repair & Maintenance
38-SMP	System Management & Planning
39-OES	Operational & Engineering Support
40-SIT	Site Maintenance
41-SMF	Site Medical Facility
42-MHA	Munitions Holding Area
43-DPE	Demilitarization Protective Ensemble